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NOTE

Instead of raising the price of membership, and in order to meet the requirements of the War Industries Board, and also because of the drafting of the whole Editorial Staff the July, August and September numbers have been dropped out for 1918. Vol. IX contains only 8 instead of 12 numbers.

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Date of issue of this number, July 15, 1919.

A HYBRID BETWEEN WHEAT AND RYE

The two parents are shown at the extreme right and extreme left. The first and second generation from the cross are shown in the center, F_1 and F_2. (Frontispiece.)

FERTILE WHEAT-RYE HYBRIDS[1]

Crosses Between Wheat and Rye Are Usually Sterile—A Fertile Cross May Have the Good Qualities of Wheat and the Hardiness of Rye

H. H. Love and W. T. Craig

(In Coöperation with the Office of Cereal Investigations, U. S. Department of Agriculture)

AT VARIOUS times crosses have been made between wheat and rye. One of the earliest to report was Wilson (1) who was followed by Carman (2), Rimpau (3) and others, namely, Signa (4), Schliephacke (5), Miczynski (6), Nakao (7), and Tschermak (8). The result of most of the crosses was that the hybrid plant was sterile. Only Miczynski, Carman and Rimpau obtained fertile hybrids. Later we have the work of Jesenko (9), Leighty (10) and McFadden (11). The latter reports the result of a wheat-rye cross which was sterile. Leighty reviews the work of Carman and later gives some of his own work where he produced wheat-rye hybrids artificially and also found some natural hybrids between wheat and rye.

Jesenko reports upon what seemed a fertile wheat-rye hybrid but, as a result of further investigation, concluded that what he supposed was a fertile hybrid was really the result of a backcross between the F_1 and wheat. He also believed that the fertile hybrids obtained by Rimpau and Miczynski were the result of backcrossing with wheat and not the result of self-fertilization. Jesenko backcrossed very many F_1 flowers with both wheat and rye. When he used wheat he obtained about three seed per thousand flowers pollinated, and with rye he obtained only one seed from 4,800 flowers pollinated. When the F_1 was backcrossed with wheat the resulting F_2 plants were very similar to wheat, and the result when rye was used was a plant very similar to rye.

Jesenko suggests that it is possible that in the egg cells the amount of wheat and rye plasm is not equally distributed but that sometimes more wheat and, again, more rye plasm is present. Then, when a pollen grain from a wheat plant would fertilize an egg cell with little rye plasm and nearly all wheat, a plant similar to wheat would be obtained. This plant would be fertile. As the rye plasm is increased, in the egg cells the plant developing will be less wheat-like and less fertile. This would continue until complete sterility would be obtained. The reverse would be true if a pollen grain from rye would fertilize an egg cell containing more rye plasm than wheat. The plant would be fertile and more like rye. As the rye plasm decreases and the wheat plasm increases the resulting plant would look less like rye and would be less fertile until complete sterility would be reached.

A SUCCESSFUL CROSS

A number of crosses between wheat and rye have been made by the authors. Most of these have been sterile in F_1 and no attempts were made to cross them back with wheat or rye. So far as the characters of these hybrids are concerned, they agree with the results usually obtained when this cross is made, in that the hybrid is intermediate in many respects. Two hybrids between wheat and rye have been fertile, and it is planned to describe here briefly the results obtained, so far, from one of these crosses.

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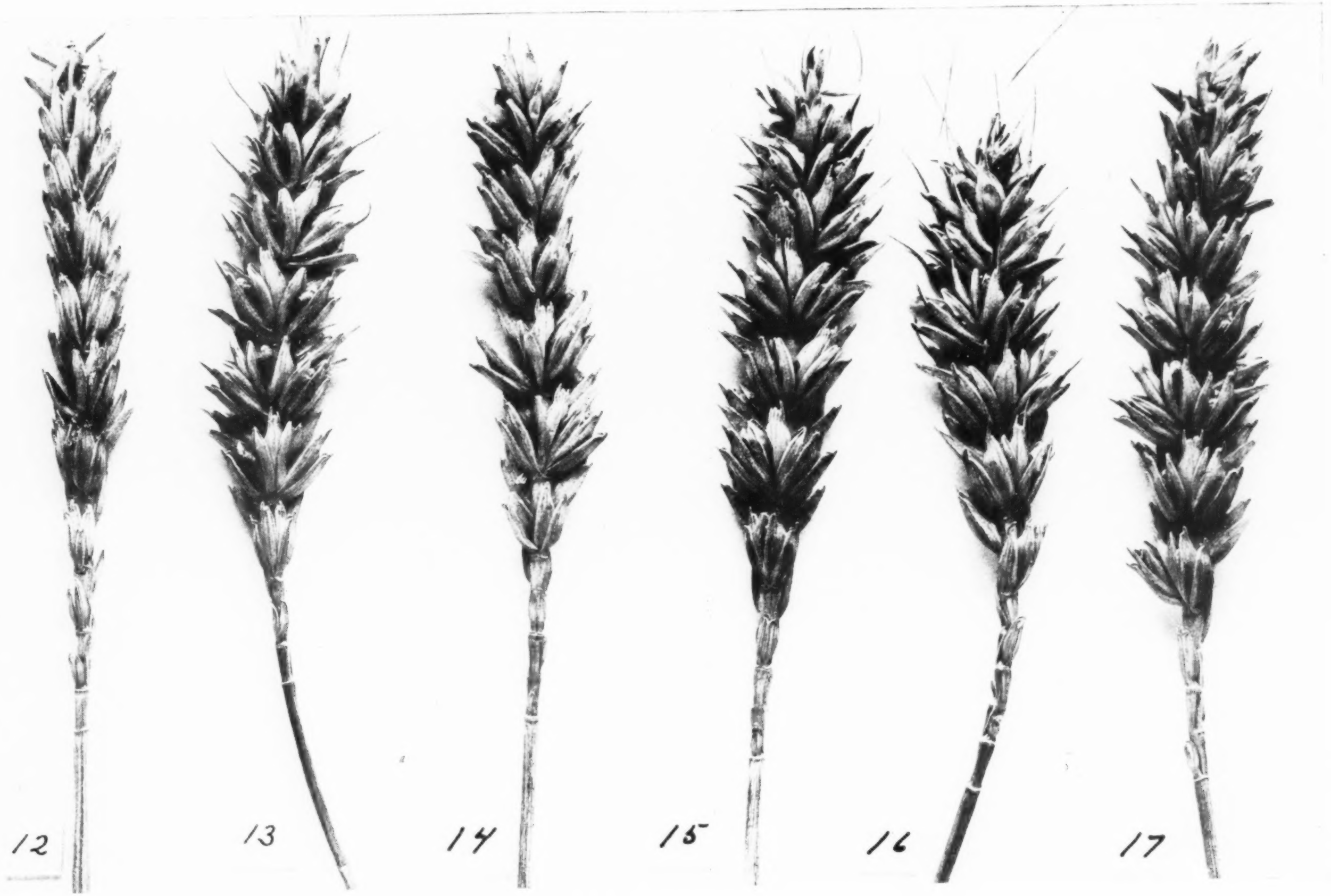
[1]Paper No. 76, Department of Plant Breeding, Cornell University, Ithaca, N. Y.

HEADS FROM THE DIFFERENT PLANTS OF THE F_4 GENERATION

The heads are more like wheat than they are like rye, yet in some respects they indicate their hybrid origin. (Fig. 1.)

HEADS FROM THE DIFFERENT PLANTS OF THE F_4 GENERATION

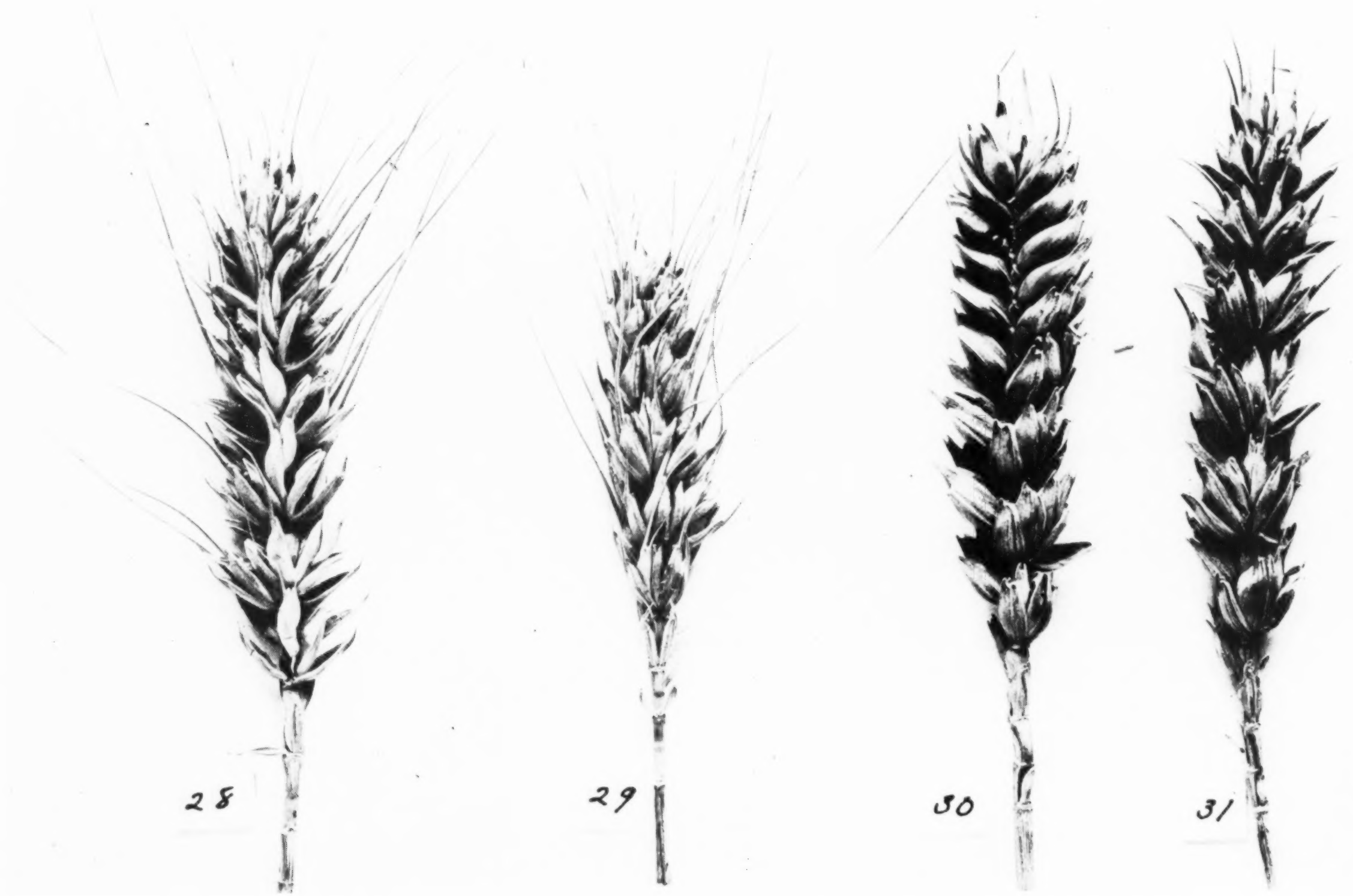
The kernels showed some variation and seemed from their shapes to show differences that are not common among wheat hybrids. Most of these kernel types are shown in Nos. 11 and 12. (Fig. 2.)



HEADS FROM THE DIFFERENT PLANTS OF THE F_4 GENERATION. (Fig. 3.)

HEADS OF THE DIFFERENT PLANTS OF THE F_4 GENERATION. (Fig. 4.)

HEADS FROM THE DIFFERENT PLANTS OF THE F_4 GENERATION. (Fig. 5.)

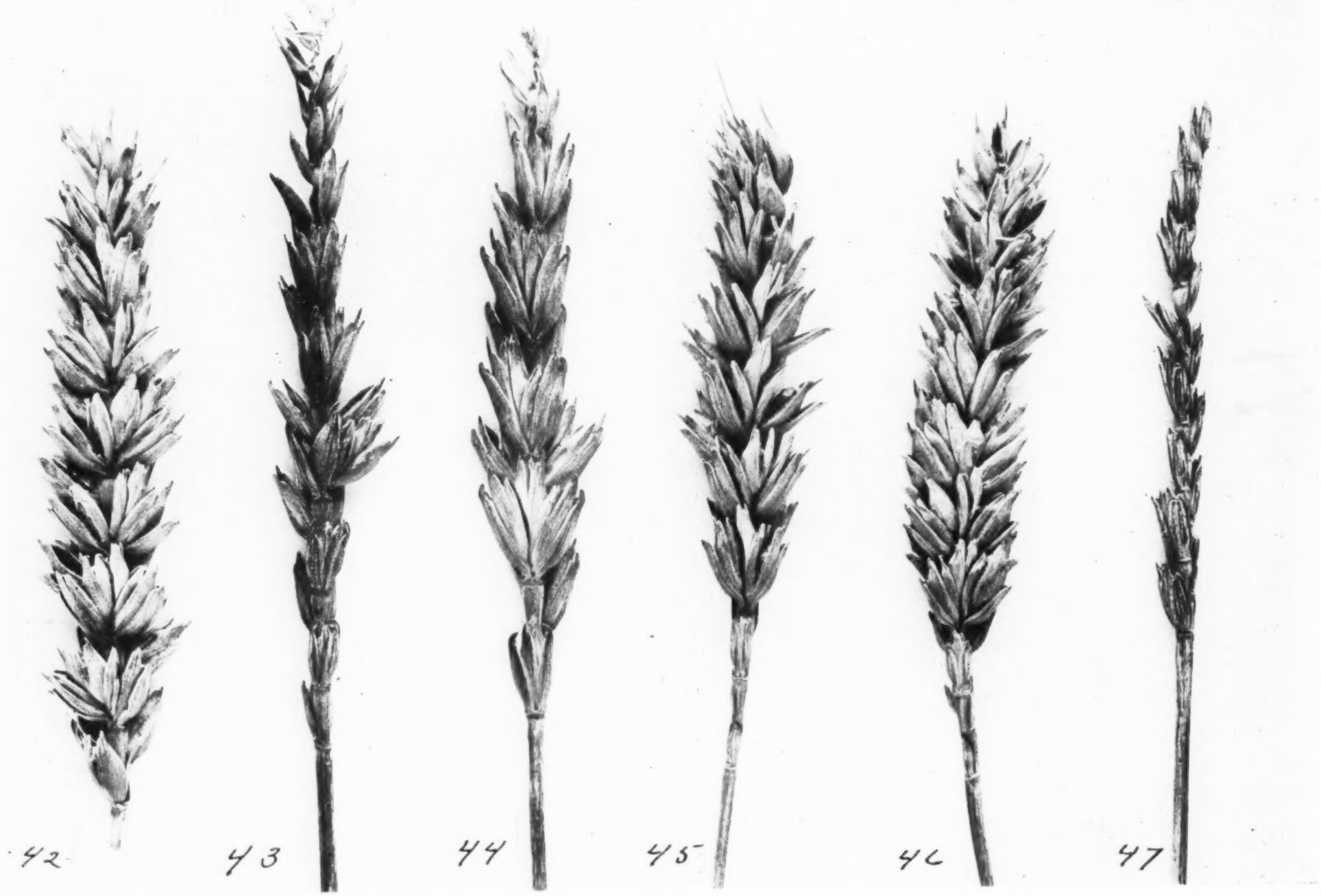


HEADS FROM THE DIFFERENT PLANTS OF THE F_4 GENERATION. (Fig. 6.)

HEADS FROM THE DIFFERENT PLANTS OF THE F$_2$ GENERATION

HEADS FROM THE DIFFERENT PLANTS OF THE F, GENERATION

Head No. 39 is much like rye in regard to the awn development and chaffy grains. Fig. 3



HEADS FROM THE DIFFERENT PLANTS OF THE F_4 GENERATION

There is considerable variation as to the degree of sterility found. Certain ones are fully fertile while others are nearly sterile. Nos. 43 and 47 are examples of the nearly sterile. (Fig. 9.)

The variety Dawson's Golden Chaff was crossed with common rye and from this cross one plant was obtained. This F_1 plant gave every indication that it was a wheat-rye hybrid. It had a few awns develop particularly at the tip of the head. The glumes were brown and intermediate between those of wheat and rye. They were keeled more like rye and ciliate. There was only a slight pubescence of the peduncle. While in some wheat-rye hybrids this is very pronounced, other hybrids have been obtained which are not at all pubescent.

This hybrid plant was not completely fertile but one seed was obtained which produced a plant in the following generation. The parent heads and a head from each of the F_1 and F_2 plants are shown in frontispiece. The F_2 head was much like F_1, but more awns developed. It showed in many ways its rye parentage. The glumes were sharply keeled and ciliate. More awns developed than in the case of the F_1 type although this plant was not as fully awned as rye. The peduncle was not pubescent at all. Only one viable seed was obtained from this plant. This seed produced a healthy plant the following generation. This plant in appearance was more wheat-like than either the F_1 or F_2 and produced many seed. It did not show its hybrid nature to any great extent so far as the head characters are concerned.

A number of seed were sown from this plant and an F_4 generation was grown. The plants resulting from these seed were very variable so far as awns, color of chaff and color of kernel are concerned. The color of chaff, beards and color of kernel seemed to all follow a simple Medelian ratio of 3:1, thus indicating that segregation in wheat-rye hybrids occurs the same as when two varieties of wheat are crossed. It should be noted that the color of kernel of the wheat parent was white, so that any color must have come from the rye. The heads are all more like wheat than they are like rye, yet in some respects they indicate their hybrid origin. A number of these heads are shown in Figs. 1-2, Nos. 2–10. Head No. 39 was much like rye in regard to the awn development and ciliated glumes. It is evident that there is considerable variation as to the degree of sterility found. Certain ones are fully fertile while others are nearly sterile, for example Nos. 43 and 47 (Fig. 9).

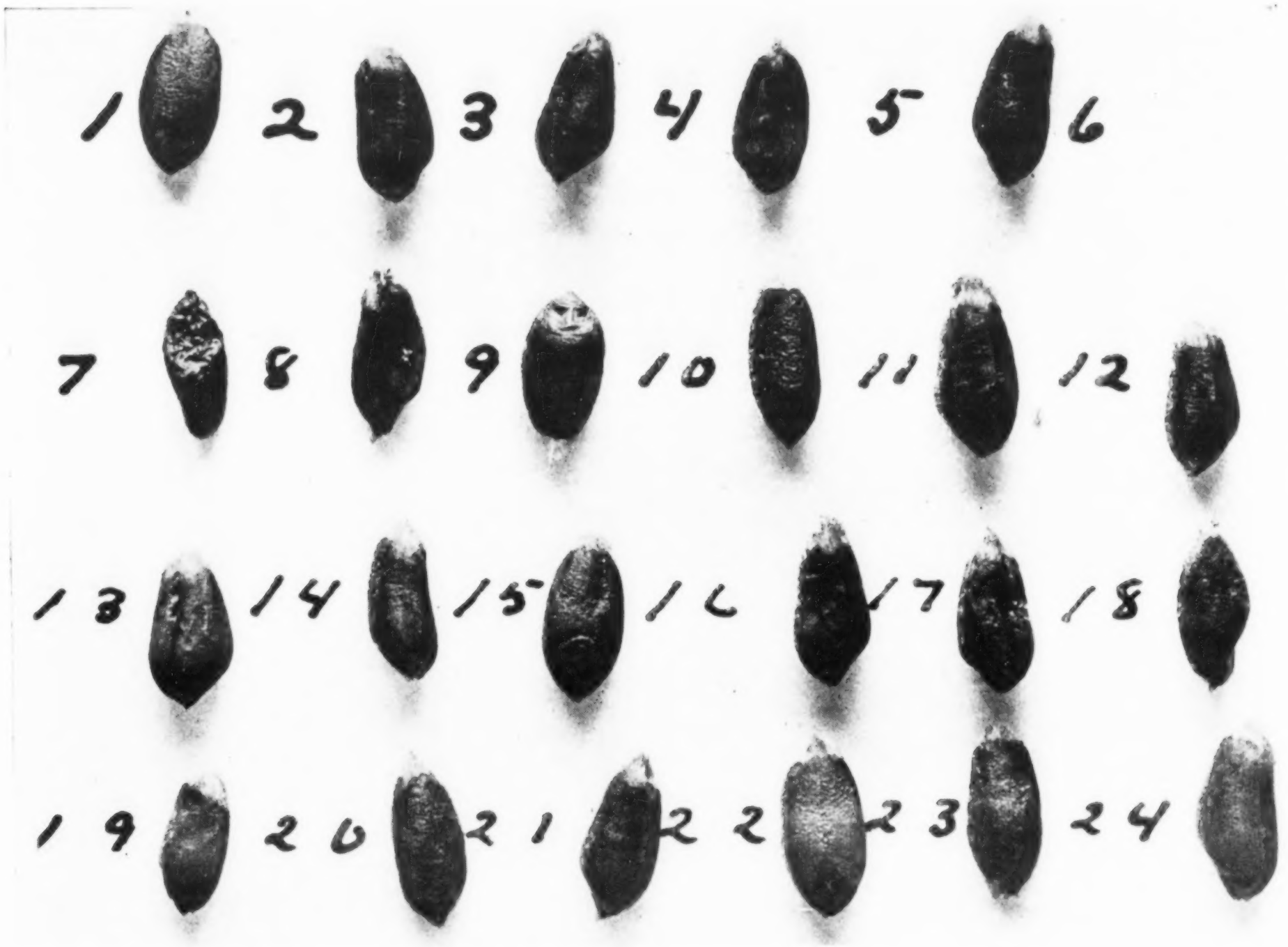
The kernels showed some variation and seemed from their shapes to show differences that are not common among wheat hybrids. Most of these kernel types are shown in Figs. 2 and 3, Nos. 11 and 12. In regard to the general appearance of the plants many of them showed their hybrid nature by the color of the stems and certain likenesses to rye. This was so apparent that a visitor on looking over the cultures in the greenhouse remarked on their rye-like nature without knowing what the series was. None of the plants had the pubescent peduncle as the F_1 did, but as this pubescence was lacking in F_2 these F_4 plants would not be expected to possess this pubescence. Since known F_1 wheat-rye hybrids occur without the pubescence it is not a certain criterion of a wheat-rye hybrid that it was formerly thought to be.

Some of these F_4 families have been carried further and they continue to produce plants that, so far as the heads are concerned, are more wheat-like in their nature, yet so far as the plant is concerned show some resemblance to rye.

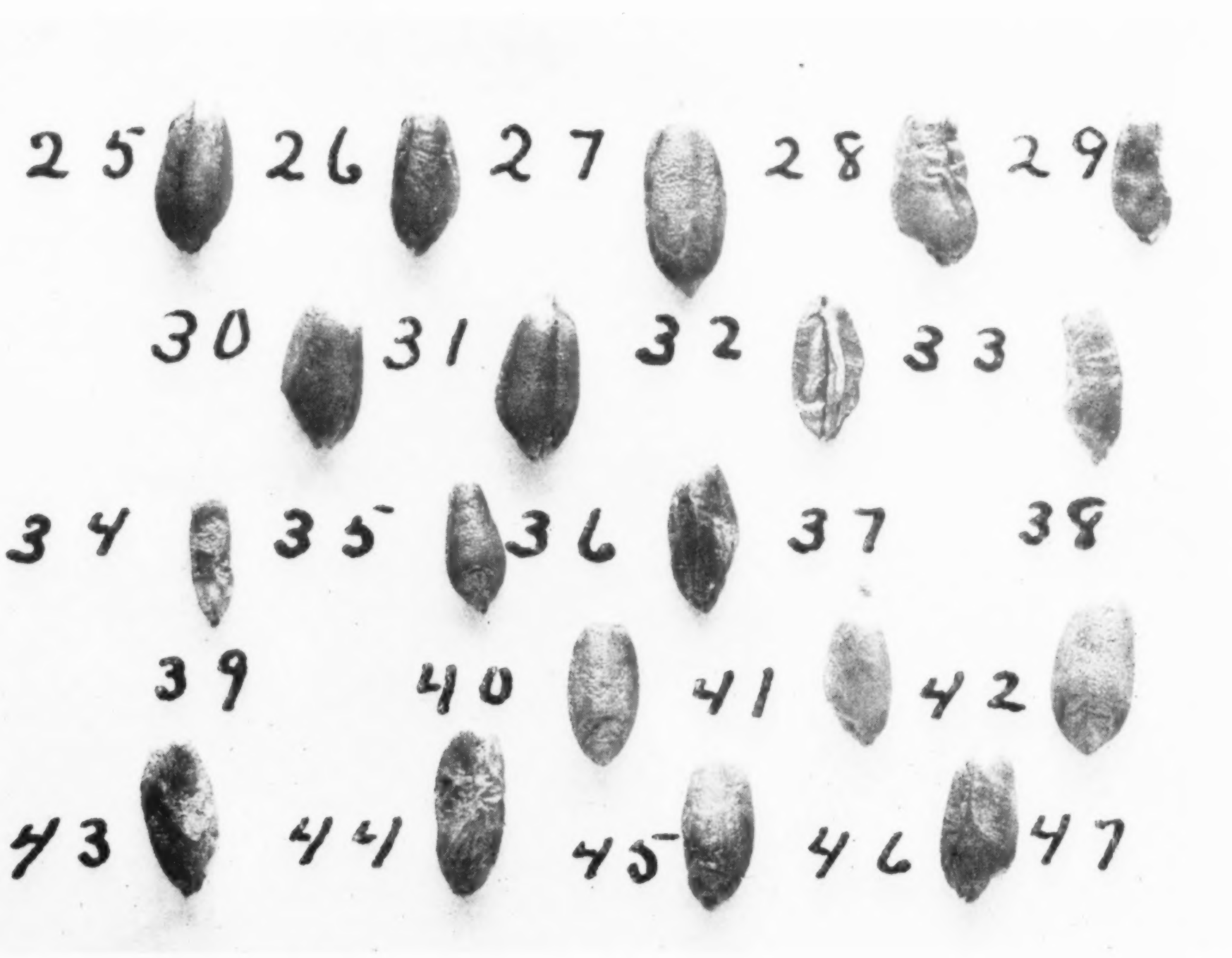
WINTER HARDINESS

Some of these hybrids are now being tested under field conditions to determine whether they may have inherited any of the winter hardiness of rye. If it is possible to obtain such a plant with the good qualities of wheat, one would be able to sow later than is now done and still obtain a good stand. The importance of this is self-evident and would mean much to wheat growing areas where winter killing is severe.

From these results it seems without doubt that we have a fertile wheat-rye hybrid and that the seed which developed on the F_1 plant was the result of self-fertilization and not a result of a backcrossing with wheat or rye. If



KERNELS OF DIFFERENT PLANTS FROM THE F_3 GENERATION. (Fig. 10.)



KERNELS OF DIFFERENT PLANTS FROM THE F_4 GENERATION. (Fig. 11.)

this had been so, and accepting Jesenko's conclusion, the plant would either have been more wheat-like if crossed with wheat, or more rye-like if crossed with rye. The plant was more like the F_1 than either wheat or rye and was partially fertile, and the plants produced from it wheat-like in appearance, yet showing some relationship to rye.

The fact that there is some partial sterility among the later plants and that some of the plant characteristics are like rye is further evidence that we have a fertile hybrid between wheat and rye. It may be possible to find certain wheat varieties that may produce fertile wheat-rye hybrids. The results already obtained would lead to that conclusion.

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A Freak Papaw (Carica Papaya)

The Editor,
Journal of Heredity.
Dear Sir:

As generally found, the papaw fruit is green in color when immature, and, though in some cases it continues so, even when fit for eating, it often shows an orange coloration, running down the fruit in bands. Occasionally the entire fruit turns orange yellow—generally when left to ripen on the tree.

In the village of Dippittigala, about 6 miles from the provincial town of Ratnapura, in Ceylon, the writer observed a clump of papaw trees of a strange appearance. All the fruits, from the smallest to the largest, were of a sulphur yellow color, and the leaves wore a marbled appearance in which the same color predominated. The smaller fruits were so light in color that they were almost white. On enquiry, the fact was elicited from one of the prominent residents in the neighborhood that the seed from ripe fruits of this strange variety gave rise to progeny true to type. Specimens were secured and brought to Peradeniya, where plants raised from seed were found to produce the ordinary green variety.

Recently the writer visited the same village and made further enquiries, and was able to verify the fact that while some of the seed from the trees in question bred true, others did not. The appearance of the trees at Dippittigala suggested the name of "Albino Papaw." The question arises—is this a case of Albinism?—C. Drieberg, *Superintendent of School Gardens, Peradeniyd, Ceylon.*

POPULATION SCHEDULE FOR THE CENSUS OF 1920

HARRY H. LAUGHLIN

Eugenics Record Office, Cold Spring Harbor, Long Island, N. Y.

THE FOURTEENTH decennial census of the United States will be taken as of January 1, 1920. The mere counting of the people has long ceased to constitute the chief activity and purpose of the federal census. Formerly the census organization was made and dissolved for each decennial canvass and tabulation, but by the act of March 6, 1902, Congress provided for a permanent Bureau of the Census which was created in the Department of the Interior. Later, when the Department of Commerce and Labor was organized, the Bureau of the Census was transferred thither. At present this Bureau is part of the Department of Commerce. Thus the impending decennial census will be the second taken under the permanent organization. The intercensal years are occupied by analyses and publication of decennial census material, and in making and publishing the results of many special surveys.

THE POPULATION SCHEDULE

Section 8 of the Act of March 3, 1919 (an Act to provide for the fourteenth and subsequent decennial censuses) reads: "Sec. 8. That the Fourteenth Census shall be restricted to inquiries relating to population, to agriculture, to manufactures, to forestry and forest products, and to mines and quarries. The schedules relating to population shall include for each inhabitant the name, place of abode, relationship to head of family, color, sex, age, conjugal condition, place of birth, place of birth of parents, nationality or mother tongue of all persons born in foreign countries, nationality or mother tongue of parents of foreign birth, number of years in the United States, citizenship, occupation, whether or not employer or employee, whether or not engaged in agriculture, school attendance, literacy, tenure of home and the encumbrance thereon, and the name and address of each blind or deaf and dumb person." . . .

Then follow the specifications for the schedules relating to agriculture, to manufactures, to forestry and forestry products, and to mines and quarries, each set of which is equally extensive with that for population. The value to the nation of the summarized and digested information secured by these schedules is of course very great.

EUGENISTS AND GENEALOGISTS DESIRE AMENDMENT TO POPULATION SCHEDULE

In 1916, Alexander Graham Bell, Chairman of the Board of Scientific Directors of the Eugenics Record Office, proposed a resolution which was unanimously adopted by this body, to the effect that it would be highly desirable in the interests of American family history studies if to the census schedule there were added two items: first, "name of the father of the person enumerated;" and second, "full maiden name of the mother of the person enumerated." The Eugenics Research Association, through its Executive Committee, in following up this purpose, presented on February 21, 1919, the following memorial to the Director of the Census:

"To the Hon. Samuel L. Rogers, Director of the Census of the United States, A Memorial:

"In the interest of race betterment in the United States, the Eugenics Re-

search Association, by formal vote of its Executive Committee, respectfully memorializes the honorable Director of the Census to provide in the forthcoming general enumeration of the Census of 1920, and in all future censuses, for recording the *name of the father and the maiden name of the mother of every person enumerated*. This could be done by adding to the enumeration sheet for the Census of 1910, between columns 11 and 12, two 1½-inch columns, the pair of columns headed *Ancestry;* the first column of the pair sub-headed *Full Name of Father of this Person;* the second column of the pair sub-headed *Full Maiden Name of Mother of this Person.*

"We respectfully set forth the very great value in this and in future censuses of the facts which would thus be secured:

"1. The family ties would be established and thus all census enumeration records would become available for genealogical and family pedigree-studies.

"2. Persons of the same name would be distinguished by connecting each other with the name of his own father.

"3. The position in the family tree of married men and women would be established.

"4. The relationship of unmarried women in the household would be established.

"5. Family records would be preserved intact, despite the change of surname and of surname spelling.

"6. If used in a series of censuses, this one item would enable the student of American families to construct, from the census records alone, the family trees of all American families. Thus by this relatively simple correction, the United States Federal Census reports would constitute the greatest and most valuable ge..ealogical source in the world.

"This proposition was first urged by Alexander Graham Bell at the annual meeting of the Board of Scientific Directors of the Eugenic's Record Office in 1916, and was unanimously adopted by this Board, which at that time consisted of: Alexander Graham Bell,Chairman; William H. Welch, Vice-Chairman; Lewellys F. Barker; Irving Fisher; T. H. Morgan; and Charles B. Davenport, Secretary and Resident Director. The experience of Dr. Bell in practical census work makes his opinion on this particular matter especially worthy of your careful consideration.

"Respectfully submitted,

"February 21, 1919."

Besides the arguments enumerated in this memorial in favor of supplementing the census records by the addition of "the name of the father and the full maiden name of the mother of every person enumerated," the following points are presented:

1. By the use of population-records containing these facts, the individual could be located from census to census and from generation to generation. Thus not only could the statistician secure from the census returns mass data descriptive of general demographic conditions, but also he could trace individual and family fortunes. This would enable the analyst to measure the personal "overturn" in population, wealth, occupation and residence. Such investigations would be of the greatest social and political value.

2. Except for persons who are born and who die within the same intercensal period, the entire genealogical trees of all families of the American population, together with many facts of biography and personality, beginning with the oldest generation living at the inauguration of the system, could be constructed and permanently maintained.

3. Fragmentary data concerning ancestors would be sufficient clues to enable the investigator, by the use of the records asked for, authentically to restore a family tree.

4. The American people are learning to treat family-history archives more as pedigree-records for use in tracing the descent of natural traits, than solely as genealogical studies whose chief motive is superficial social distinction. The desired census data would therefore be put to a very useful purpose.

5. The records of parentage as given by the census would be of great legal value in supplementing local records

in cases involving inheritance and property, indeed in many instances the census records would constitute the only documentary evidence of parentage.

To summarize: Present census methods give statistical pictures of the population, but do not trace personal or family fortunes. The addition of only two items to the population schedule—"the name of the father, and the full maiden name of the mother," would permit the analysis of census returns on the personal and family-history basis. The fortunes of the nation are indissolubly united with those of the individual, and since the rate and extent of "overturn" in personal fortune is an index to the quality of national growth, the value of the proposed analyses would repay many times the relatively slight additional cost and effort involved in adding the two desired items to the population schedule.

Six Hundred Twins Already Discovered

Twins Which Were Separated in Babyhood Especially Sought

The American Genetic Association through the generous coöperation of the press has been placed in communication with over six hundred twins and several hundred of them have sent excellent photographs illustrating in many cases most remarkable similarity. It is particularly important in the researches that are being carried out that such identical twins as have lived in entirely different environments be found and further publicity leading to the discovery of pairs of identical twins, the individuals of which have lived in different countries and have been taught from childhood different languages is desired. All communications should be directed to the American Genetic Association, Washington, D. C.

Any twin coöperating with the Association will be supplied with any special articles published relating to these researches.

The Beginnings of the Nervous System

THE ELEMENTARY NERVOUS SYSTEM, by G. H. Parker, Sc.D., Professor of Zoölogy, Harvard University. Pp. 229 53, illustrations. Price, $2.50 net. Philadelphia and London; J. B. Lippincott Co. (Monographs on Experimental Biology), 1919.

Confining himself mainly to such simple forms of life as sponges, jellyfishes and hydroids, Dr. Parker has outlined in detail the nature of the elementary nervous system, particularly with a view to showing its limitations. His point of view is described in his preface: "The dependence of human affairs upon the nervous system of man is so absolute that it was inevitable, as soon as this relation was understood, that the activities of the simpler animals should be interpreted as though these creatures were miniature human beings. That such interpretation was carried far beyond its legitimate bounds, even by the scientifically trained, is now admitted on almost all sides. That these bounds are vastly more restricted than has usually been supposed is certain. An approach to a clearer understanding of what they are is assured through the application of experimental and quantitative methods to the questions concerned rather than by a continuation of the older more purely observational procedure."

Why the Babies Die

INFANT MORTALITY: Results of a field study in Brockton, Mass., based on births for one year, by Mary V. Dempsey. U. S. Dept. of Labor, Children's Bureau Publication No. 37. Pp. 82. Washington, D. C., 1919.

Brockton is a center of shoe manufacture, and a prosperous New England town. The Children's Bureau surveyed it to find why the infant mortality rate was so low (96.7). It ascertained some commonplace things, and some that were unexpected, as that the mortality among babies of foreign-born mothers was lower than among babies whose mothers were native Americans. Like most of the studies the Children's Bureau has made on infant mortality, this one is statistically inadequate and misleading. The conclusion is that Brockton's infant mortality rate is not so low as it ought to be, considering the high wages paid to shoe-workers and the good municipal sanitation. The insistence on economic factors, and the failure to deal with biologic factors that might affect infant mortality, render the study of little real value.

The Inheritance of Blindness

THE BLIND, their condition and the work being done for them in the United States, by Harry Best, Ph.D. Pp. 763. New York: The Macmillan Co., 1919.

Heredity plays an unimportant part in causing blindness, according to Dr. Best. His chapter on heredity, like many other chapters of the book, is a compilation marked by little grasp of the subject, but he concludes that possibly not more than 10% of the blind owe their infirmity to inheritance. Heredity causes blindness, apparently, in a dozen or more different ways, of which cataract is the most frequent. The blind do not tend to marry in such large proportion as the normal members of the population. "The likelihood of blind offspring is not necessarily greater when both parents are blind than when one is blind and the other sighted," except in cases of consanguineous marriage, of course. From Dr. Best's citations it would seem that there are considerable data available for a study of the inheritance of blindness, but he himself has added nothing to the subject.

A Compilation on Subnormality

PROBLEMS OF SUBNORMALITY, by J. E. Wallace Wallin, Director of the Psycho-Educational Clinic, Board of Education, St. Louis; with an introduction by John W. Withers, Ph.D., Superintendent of Public Schools in the City of St. Louis. Pp. 485. Yonkers-on-Hudson, N. Y.; World Book Co., 1917.

Dr. Wallin has diligently brought together an immense amount of miscellaneous material relating in a general way to the problems of subnormal intelligence. He considers "The Changing Attitude towards the Subnormal," asks "Who is Feebleminded?", outlines his views on the proper education of feebleminded and backward children, inserts a paper an epilepsy, summarizes the present state provisions for defective children, and concludes with 46 pages on "The Hygiene of Eugenic Generation." This last chapter is marked by such a confusion between eugenics and euthenics, and such an uncritical handling of facts and authorities, that it has little value. Throughout the book Dr. Wallin wisely insists on proper use and standardization of mental tests, and condemns attempts to include too large a proportion of the population in the category of feebleminded. The book is useful as a source of citations and compendium of facts gathered from the literature, but the reader in using it will have to apply the critical selection to data which Dr. Wallin himself has not applied.

PORTRAITS OF EARLY AMERICANS[1]

Recent Publication by Charles K. Bolton Shows Intermediate Type in the Evolution of the Nordic Face—Eyes and Nose Show the Most Interesting Changes

FREDERICK ADAMS WOODS

Lecturer on Biology, Massachusetts Institute of Technology

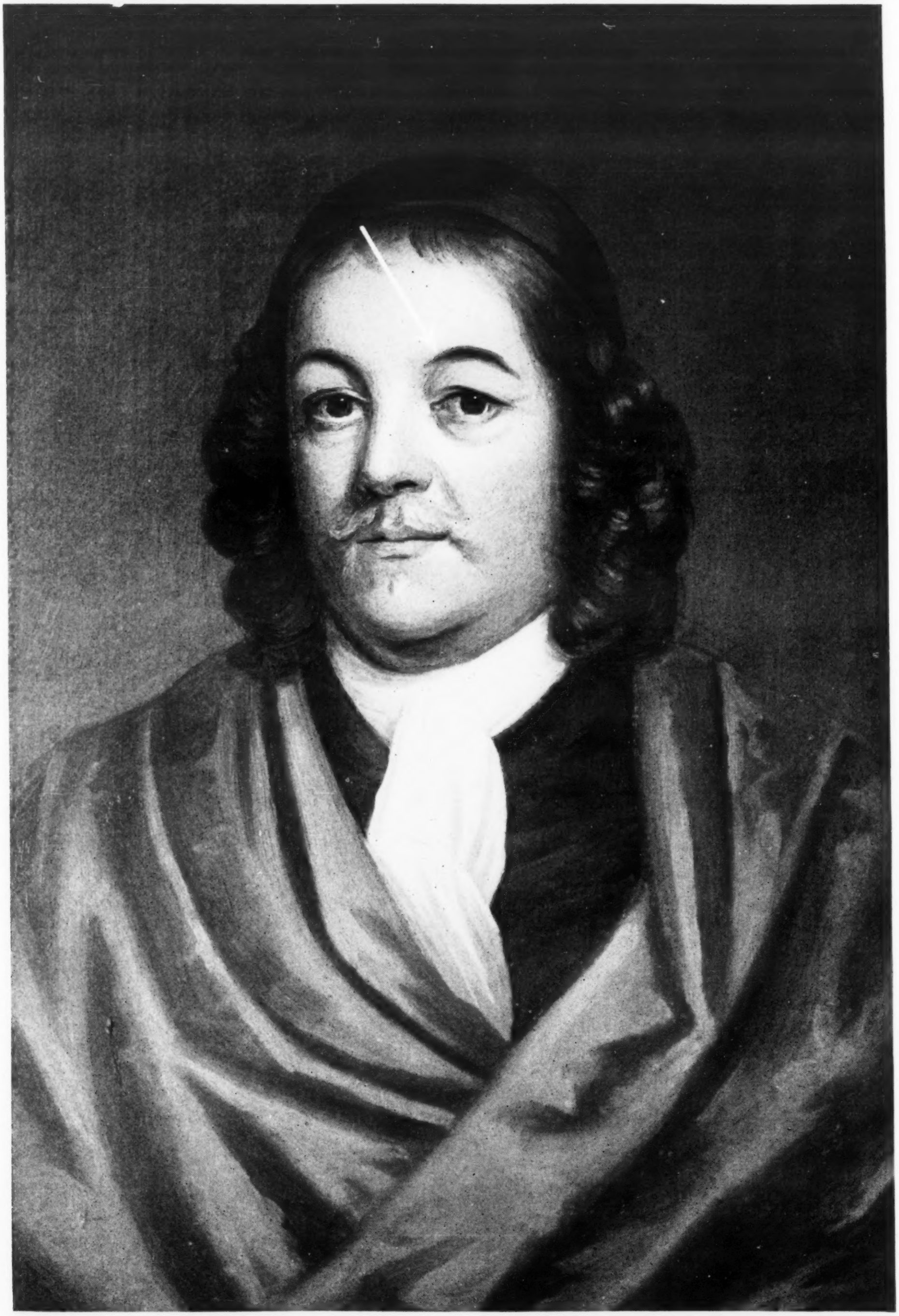
FOR four or five hundred years artists have been making graphic records of the human face. Yet this historical, anthropological, and often beautiful material has been but little utilized in the study of evolution. That it can be utilized to a very great extent can scarcely admit of doubt. Racial types are often no more clearly marked in the faces of the living than in the portraits of the dead. Eye-color, hair-color, the shape of the bones of the head, and more particularly the bones of the face, the modeling and even the expression of the mouth, are all significant and vary in diverse races, families, and social classes. Character and intelligence are usually clearly written in physiognomy. It only remains for the intuitive perception of the expert to be supplanted by measurements and inductive analysis, and the human face, containing the most vital, the most varying, the most revealing of all anthropological data, will be promoted to its position of importance in classifying mankind.

How do we recogni[illegible] an old friend or anticipate a new [illegible]? How do we determine a pers[illegible] probable attractiveness? Ho[illegible]we quickly differentiate the s[illegible] racial subdivisions of mankind? We do not measure the shapes of their heads. We look them squarely in the face. And, undoubtedly very limited portions [illegible] the face suffice, —notably the [illegible] region around the mouth and nostrils and certain indications about the eyes. For instance, the Mongolian eye is characteristic, although occasionally found in other races. The Semitic nostril and upper lip are, in that race, so ancient and universal that they appear with equal constancy and obviousness in the earliest profile drawings in Babylonian days.

DEARTH OF ANATOMICAL MATERIAL

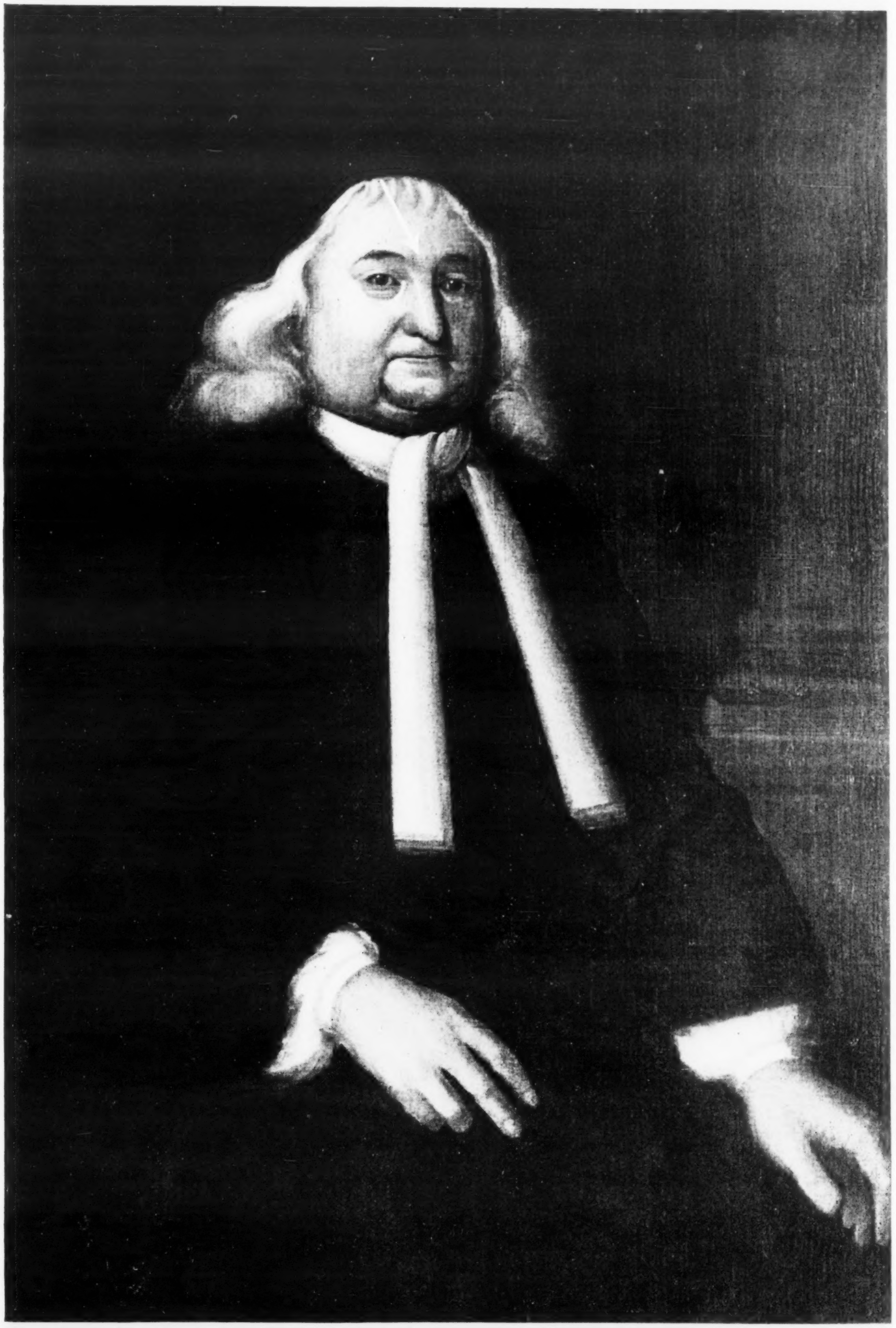
Evidences of anatomical evolution are not lacking if one goes back to prehistoric times. The Neanderthal and other very early skulls, human or semi-human, are small in cranial capacity and primitive in shape. Anthropologists have found but little evidence of recent human evolution—that is, within historic time. We do judge from the sizes of suits of armor that men are somewhat larger than they were a few hundred years ago, but increased body size may not mean intellectual evolution. The reason why anatomists have failed to find visible evidence of recent evolution is because they have attended to every part of the body except that one external feature which is most indicative of character and intelligence. If there be a real, recent mental evolution, and if anatomists for centuries had been studying the internal structure of the brain after the methods of modern technique—mapping brain regions and counting brain cells—they would have found such evolution. But, naturally, the older anatomists kept no such records; and now, after the once living gray

[1] Review and supplementary research based upon "The Founders: Portraits of Persons Born Abroad Who Came to the Colonies in North America before the Year 1701," with an introduction, biographical outlines, and comments on the portraits, by Charles Knowles Bolton. In 2 volumes. *The Boston Athenaeum*, 1919.



REV. SIMON BRADSTREET

The arrow calls attention to the eyebrow, which is very high above the eye. This is typical in the early portraits of English people but not in the early portraits of Italians. Also, the nose is broad at the top and the eyes are far apart. The arrow has been added by the reviewer. (Fig. 13.)



SAMUEL SEWALL, 1652-1730

The arrow calls attention to the broad nose and high upper eyelid. Both were common in the sixteenth century. They were not uncommon in the seventeenth and eighteenth centuries. They are rare today but can be found occasionally. (Fig. 14.)

STEPHEN SEWALL, 1657-1725

Brother of Samuel Sewall (Fig. 14). The family resemblance is striking. The arrow calls attention to the high eyelid very similar to that of his brother. Note the great vertical distance between the point of the arrow and the center of the eyeball. (Fig. 15).

matter has gone forever, the one anatomical record most likely to reveal the inner brain is the face itself, which may be regarded in more ways than one as the next thing to it.

THE USE OF PORTRAITS

In order to make satisfactory studies of ancient portraits, good photographic copies are needed, and many specimens must be brought together for comparison and analysis. Here we are in an advantageous position over our forefathers, who did not have photography to make possible a large collection of good copies. Also, to make a fair comparison, a collection of complete portraits of some one race or historical group is desirable.

In the collected photographs of portraits in famous national galleries we, to a certain extent, have reasonable completeness, though all portraits must be classified according to period and nationality. The work on Early Portraits in the National Portrait Gallery; London, (1400–1500) and Volume II (1600–1700) form suitable collections for studies of measurement and analysis, since all or nearly all belong to the strictly English breed.

PORTRAITS OF THE FOUNDERS

Recently Charles K. Bolton, Librarian of the Boston Athenaeum, has brought together and published a very important collection of photogravures of all the portraits obtainable of the founders of the colonies in North America who came before 1701. Such a collection is valuable and satisfying on account of its completeness. It is not likely that more than a very few portraits, not in the collection, will ever be unearthed. As the author truly says:

"The value of the pictures here reproduced will increase with the years, for they represent men and women who came together from the countries of Europe to found colonies which have been federated into a great republic. Inevitably a few portraits have been overlooked, and when these have been added we shall have between the covers of one work all the faces that we shall ever see from that historic past. The portraits are of value for their evidence of dress, armor, and fashion; but there is a still more fundamental significance in these faces as a group, for they show the type of the immigrant of the seventeenth century—austere, adventurous, and resolute."

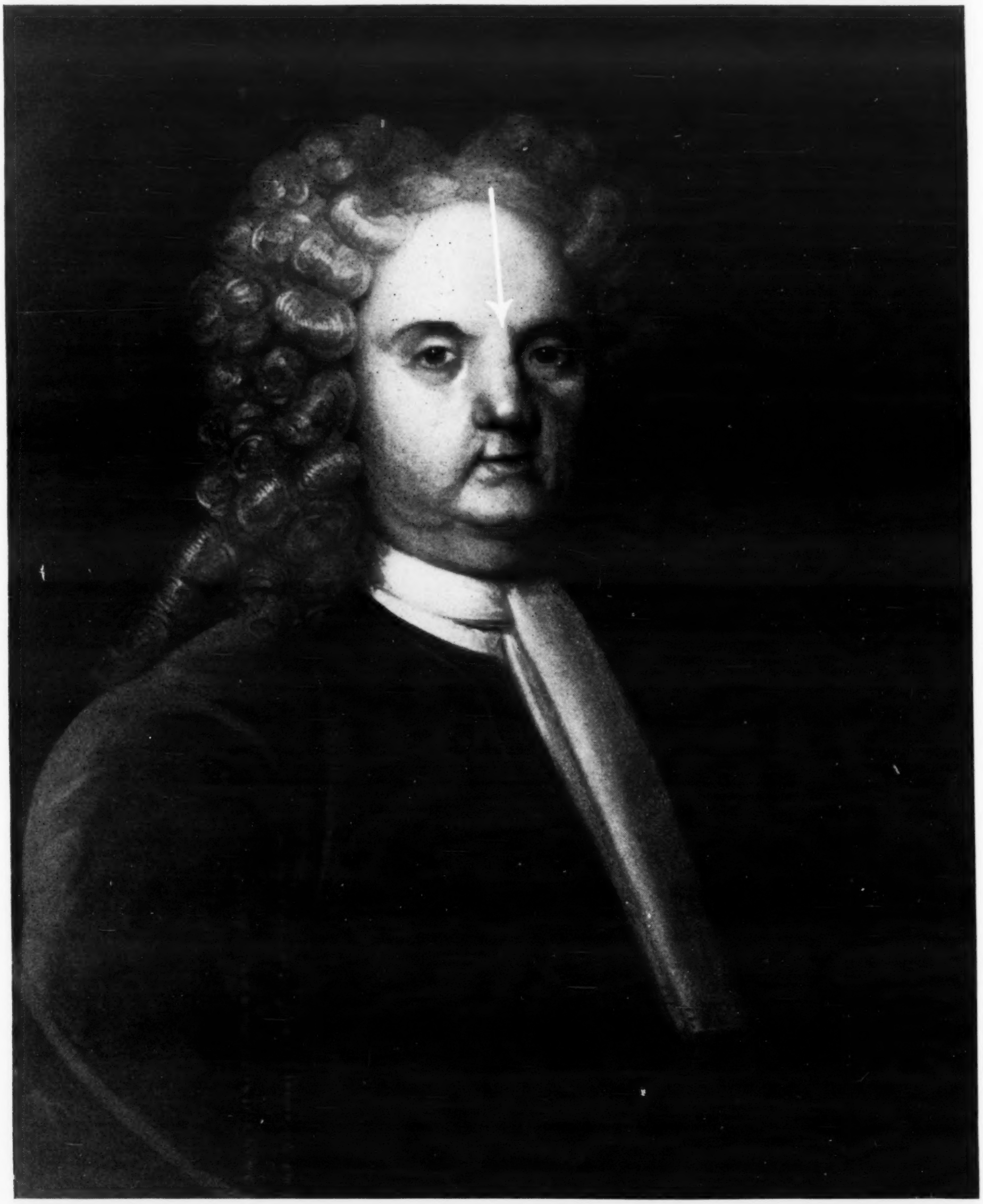
Mr. Bolton in his Introduction accepts my conclusion, reached some years ago from a study of Italian, French, Flemish and English portraiture, that the face of the Nordic has actually changed since the beginning of the sixteenth century.[2] The greatest change is in the region of the eyes. The eyes are now more often near together than formerly. This means that the breadth at the top of the nose which is generally associated with eyes wide apart, is frequent in early portraits and disappears with the course of time. This unusual breadth at the top of the nose is indicated by the arrows in Figs. 13–16. The eyes in these portraits are far apart.

The second point of distinction is the distance between the eyebrow and the pupil of the eye itself, that is, the eyebrow in the early portraits is often high above the eye, the upper eyelid presenting a flat surface. The eye is not set in under the orbital arch as is usual today. The cheek-bones are somewhat less prominent now than formerly, but otherwise the face has changed but little. Figs. 13, 14, and 15 show the eyebrow very high above the eye, as is indicated at the points of the arrows.

NOT AN ARTISTIC MANNERISM

Portraits are not, like photographs, mechanical records. Consequently the personal equations of the different artists must be taken into consideration. There is, for instance, the well-recognized "Sir Peter Lely eye," and one is inclined to think that much of this change in eye-form is due to an improvement in the art of painting. But this will not stand the test of comparative analysis. While most of the earliest portraits are crude in their primitiveness (those prior to Holbein, for instance), the portraits by Holbein

[2] Problems in Eugenics. London, 1912, p. 251.



A SIXTEENTH CENTURY NOSE

The nose, rough in outline and broad at the top, was common to Nordics in the sixteenth century, and by no means rare in the seventeenth. Here the upper eyelid is more like a modern, but the eye is by no means as deep set as is usual today. The portrait is that of Nathaniel Byfield, 1653-1733. (Fig. 16.)

himself, who was doubtless an accurate realist, are replete with this early or mongolioid type. Not all of the Holbeins show this characteristic. Some are always in a median or doubtful grade between the early and the late types, but the number of distinctly modern "eye-nose regions" is always enumerable, and it is this increase in proportionate numbers through the centuries, without regard to the amount of mastery in the art of portraiture, that makes it improbable that the change represents anything less than a real evolution in the bony structure of the face. In other words the archaic type of eye is as common in the finished and accurate work of any given period as it is in the cruder work.

The faces of the upper classes among the Nordic people have approached toward the Mediterranean or even toward the Greek type. Early Greek sculpture shows this mongolioid feature, but it is not at all certain that this was merely because it was primitive art. Primitive Italian art does not show the early type,[3] except nearly always when the Virgin is depicted. She is also represented with very high eyebrows and eyes far apart in most of the later paintings of the sixteenth century. The Mediterranean peoples, including the Italians of the Renaissance, never, except in a small percentage of instances, exhibited the ancient northern type of eye and nose.

Among modern Nordics the ancient type still persists among perhaps 10 to 15% of the whole population.[4] Many accurate measurements have been made from photographs of English, French, Flemish, and Italian portraits.

In the case of Mr. Bolton's fine collection of early American likenesses, I have merely gone through the two volumes and placed as nearly as possible each in one of three grades. There are, out of 113 authentic portraits (sufficiently clear and available for comparison), about 37 of the ancient type, 37 doubtful or intermediate, and 39 modern, or low in eyebrow, with eye well under the orbital arch. The earliest authentic portraits of the Nordic upper classes, or well-to-do upper middle classes, *i. e.*, persons who were able to have their portraits painted, show more than 50% of the early type; the same class, roughly speaking, in America today shows only 10 or 15% of this form. The faces of the seventeenth and early eighteenth century as revealed in Mr. Bolton's collection show 32.8% Thus the middle period fits in, as it should, part way between the two.

CHARACTERISTICS OF THE PURITANS

The "Portraits of the Founders" forms not only a magnificent and thorough historical collection, analyzing the authenticity and history of each picture, but it also, in a novel way, reveals the characteristics of the Puritans and the Cavaliers. Rev. Simon Bradstreet has, I should say, a very pleasant face (Fig. 13). It is fully in accordance with his reputed character. Such agreeable faces are, we must admit, rare among the portraits of early New Englanders. Sir Richard Saltonstall, John Leverett, Mabel Harlakenden, Thomas Amory, Rev. Hanserd Knollys, Richard Middlecott, James Bowdoin, Margery Pepperrell, Sir Henry Vane, Penelope Winslow, Mary (Luttrell) Winthrop and Stephen Winthrop present few of the puritanical aspects of countenance. These it may be noticed were not strictly typical Puritans, and many of them were persons of gentle blood.

The relation of history and portraiture to biology and racial heredity is not unappreciated by Mr. Bolton, who says:

"We are perhaps too ready to deal

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[3] See for instance School of Cimabue, Chiesa Inferiore di S. Francesco Assisi, and Giotto, Marriage of St. Francis to Poverty, Allegory of Chastity, etc. Here there are many faces all modern with the exception of the Virgin.

[4] The first 337 portraits in Vol. xv of the National Cyclopedia (N. Y., 1916) show, as regards height of eyebrow, 39 of the ancient type, 67 doubtful, and 231 modern.

A MORE MODERN TYPE

Here the eyes are more deeply set under the eyebrows and the nose is narrow at the top. She was born in 1674, wife of Isaac Norris, Mayor of Philadelphia in 1724. Her ancestry was gentle and in part noble and royal. Many of her descendants are living today. (Fig. 17.)

with these ancestors capriciously, either holding up our own standards to their life histories and marking the contrasts, or, on the other hand, associating their undoubted weaknesses with the age in which they lived and treating leniently frailties that should be condemned in any age. They did, many of them, come here to escape episcopacy, not to grant liberty of conscience to others. Most were bigoted in a day when the logic of convictions made men intolerant. The Puritans were the liberals of their time, but they were only a shade more tolerant than the conservative Roman Catholics; while none of them, unless we except possibly the Episcopalians, with somewhat adjustable convictions, had any affection for radicals such as Wheelwright and Williams. None of them doubted that mystics and witches were in actual communion with the devil, however widely they might differ as to punishment suitable for persons thus entangled.

"Stoughton called the immigrants to New England the choice grain of old England. The settlers in America included very few of the lowest class, many of the great middle or mediocre multitude, a fair proportion of the upper middle class, such as city merchants, clergymen, and undistinguished visitation families, and but few, if any, of the ruling class in Europe. Such as they were, however, they have dominated our political and intellectual life to this day. The Anglo-Saxon half of Boston, for example, produces a dozen eminent men to every leader produced by the Celtic half of the population.[5]

"Whatever their shortcomings may have been, these people, from north to south, were all of the dominant Nordic race so recently described by Mr. Madion Grant:

"'New England, during Colonial times and long afterward, was far more Teutonic than old England; that is, it contained a smaller percentage of small, pre-Nordic brunets. Anyone familiar with the native New Englander knows the clean-cut face, the high stature, and the prevalence of gray and blue eyes and light brown hair, and recognizes that the brunet element is less noticeable there than in the South.

"'The Southern States were populated also by Englishmen of the purest Nordic type, but there is today, except among the mountains, an appreciably larger amount of brunet types than in the North. Virginia is in the same latitude as North Africa, and south of this line no blonds have ever been able to survive in full vigor, chiefly because the actinic rays of the sun are the same, regardless of other climatic conditions. These rays beat heavily on the Nordic race and disturb their nervous system, wherever the white man ventures too far from the cold and foggy North.

"'The remaining Colonial elements, the Holland Dutch, the Palatine Germans, who came over in small numbers to New York and Pennsylvania, were also purely Teutonic, while the French Huguenots who escaped to America were drawn much more largely from the Nordic than from the Alpine or Mediterranean elements of France.'

"If we apply these facts a little more specifically to the portraits, we find that ninety-seven represent Englishmen, fourteen represent Dutchmen, nine are Frenchmen, two Swedes, two Germans, and one a Bohemian. In other words, eight-tenths were English, one-tenth Dutch, and one-tenth French and others."

In closing this notice of Mr. Bolton's volumes, we can only emphasize their value to students of history, sociology, and eugenics. Here historical material is brought together in the true spirit of natural science, for we have one of its valid methods exemplified, namely, the objective and complete collection of homogeneous data. Mr. Bolton is an historical investigator who recognizes the importance of genealogy and heredity and, still more of the need of systematic measurements before new historical generalizations are to be made.

These portraits, in conjunction with those in other volumes, enable us actu-

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[5] *Popular Science Monthly*, April, 1914, p. 400.

A TWENTIETH CENTURY FACE

(THOMAS, LORD COLEPEPER, 1634-5—1688-9)

This type of nose was rare in the seventeenth century and rarer still in the sixteenth. Here the entire nose is delicately moulded. Especially it should be noticed that the upper part of the nose projects and is not especially broad as in most early portraits. The upper eyelid is an intermediate type. (Fig. 18.)

ally to see human evolution taking place. While it is not certain that the more modern type is indicative of a higher grade of intelligence, it is probably somehow correlated with it, though there may be many exceptions to the rule. It is at least an evolution in the sense of being a change, and it is certainly a change towards what was for the ancient Greek an ideal of beauty. If the bony structure of the face has altered, presumably through some as yet unrecognized forces of selection working in conjunction with beneficial correlations, there is good reason to hold, at least as an hypothesis, that the brains of Nordic peoples are not just as they were four hundred years ago. While it may be surprising to find that a measurable human alteration took place in so short a time, it is perhaps not so remarkable if we consider how short a period man has been on earth as compared with that for his prehuman ancestors, and how vast and complex are the possibilities of some human brains compared with anything existing in the lower animal kingdom. Verily, we have been on earth only a few benighted moments and have only just begun.

The Theory of the Environment

AN OUTLINE OF THE HISTORY OF THE IDEA OF THE MILIEU AND ITS PRESENT STATUS, by Armin Hajman Koller, Ph.D., Instructor in German, The University of Illinois. Menasha, Wis.: George Banta Publishing Company, 1918. Pp. 104.

In this little book the author has compiled and compressed an enormous number of quotations from most of the famous writers who have expressed their opinions on the influence of environment on man. The scheme of the book is historical, and the sketch extends from the Hebrew Prophets to the nineteenth century. Some quotations may help to give an idea of the scope of this book.

"The Hebrew prophets see the hand of Providence in the harmony of national fate with the configuration of the globe. Hippocrates dwells upon the regularity of climatic effect on man. Aristotle notes the action of physical environment on government and national character." In another place, page 11, we find that "Giovanni Villani, the noted Florentine historian of the fourteenth century, observes with a deal of finesse that Arezzo, by reason of its air and position, produces men of great subtilty of mind." In regard to Cuvier, Mr. Koller quotes Ripley. Cuvier "had not hesitated to trace the close relation borne by philosophy and art to the underlying geological formations." It is not difficult to understand that "Cuvier did not hesitate," especially when one recalls that he did not hesitate to attack and ruin the great Lamarck, and his plea for the doctrine of organic evolution.

Mr. Koller's English is, in places, difficult to read. A great part of his book is made up of quotations, where the various famous theorists complain of each others deficiencies or praise each other warmly. In fact his book is largely made up of quotations, or quotations of quotations. It is at least an interesting contribution to the bibliography of the subject, especially as it gives the views of so many of the early writers. Nothing is said about the non-inheritance of acquired traits or modern investtigations in heredity, all of which have upset so many of the dogmatic theories of the older environmentalists. It is to be hoped that these aspects will be discussed in Part II, which the author expects to publish shortly.

WAR AND GENETIC VALUES[1]

DAVID STARR JORDAN
Stanford University, California

CERTAIN recent writers, speaking in the name of science, have attempted in different ways to minimize the recognized evils of war-selection, the destruction of the fittest in camp and in the field.

It is claimed by Dr. McFie of London, and others, that the soldier shows but slight genetic superiority (physical, mental, moral), 5% perhaps, over the men left at home. "The best for warlike purposes, not necessarily the best for any other." In the aggregate, they argue, war-selection is therefore negligible, tending at the worst to lower physical strength while leaving the mental acumen of the race unimpaired.

A writer of larger outlook, Dr. Thorstein Veblen, in his trenchant and suggestive volume "Germany and the Industrial Revolution," pushes this idea still further, regarding the reversal of selection as an undoubted fact, but of slight racial importance. Veblen bases his view on two premises: that the men killed in war do not as a whole represent high racial values, and that by the Mendelian law the descendants of the "depauperate" spared by war will in two or three generations regain the racial average.

As to the first contention, Veblen regards war as the business of the leisure classes and of the bullying type of men. The first of these he finds to be made up, in general, of inefficient social units, the second to be of inferior mental caliber. Destruction by war is thus, in his mind, largely confined to those human types which civilization can well spare.

The first contention of our author raises certain questions of fact. In general, the leisure class has been made so by incidents of wealth, society, and education. The stock is not necessarily inferior because the individual has suffered from an unfortunate upbringing. It may, of course, be at once admitted that those who find *joy* in war are in general of a low type of mind as well as of morals. Doubtless in the course of history there have been many free lances and soldiers of fortune whose extermination left the world better off. War-selection is a racial evil only to the degree in which the best are sacrificed. In modern armies the best elements are certainly drawn upon heavily. Every one knows this to be the case. Naturally the stronger the appeal of the "cause," the higher the type of men drawn to the sacrifice. To this, the selective draft, or any other form of discrimination, affords no modification.

In his second contention, Dr. Veblen urges that, according to the Mendelian principle, the ravages of war are soon restored by the tendency to revert, in mathematical proportion, to qualities of past ancestors. Thus the descendants of the weak and incapable would soon line up with the others. There is nothing in "Mendel's Law," however (so far as anyone knows), which implies that bad stock can be made good, or that any appreciable percentage of those who are, to use Veblen's term, "depauperate" through heredity, or who may suffer from other ancestral weakness, will rise above the level of their personal forbears. When the individual overtops his parentage it is

[1] This is a discussion in genetics, and for emphasis of the great and terrible truths contained therein it waives for the moment the fact that some part of the loss owing to war wastage may be balanced ultimately by advantage to humanity in the establishment of international harmony and national freedom and efficiency.—*The Author.*

because some of his still earlier progenitors were of better material or because society has misjudged the stock from which he sprang or because the mingling of germs has brought about a peculiarly favorable combination.

I find no warrant for Veblen's assertion that "under the Mendelian rule[2] of heredity, breeding from what may be called the 'depauperate' representatives of this hybrid stock should in the course of some two or three generations give the same result as breeding from the best exemplars." Nor is it true that "the best, as contemplated in this proposition, are the best for the warlike purpose, not necessarily for any other." This may have been true at some time and in some degree. It has not been true in the European wars of the last hundred years. The degree of evil in war-selection must, of course, vary with every army and with every day of war, but its importance as a factor in history cannot be questioned.

A serious view of the actual situation is expressed by Mr. Seth K. Humphrey as follows.[3]

"This war is little short of a headlong plunge into race-suicide. . . . A little play-war, offering adventure abroad, might attract . . . roving spirits whose value in any sustained effort at home is conspicuously absent, and thus not materially affect racial values. . . . It is safe to say that among the millions killed will be a million who are carrying superlatively effective inheritances, the dependence of the race's future. Nothing is more absurd than the notion that these inheritances can be replaced in a few generations. . . . They are gone forever. The survivors are going to produce their less valuable kind. Words fail to convey the appalling nature of this loss."

Again, quoting from some author not named, Mr. Humphrey gives the following excellent definition of a desirable inheritance:

"It is of that quality of brain—one might almost add quantity of brain—which leads to creative leadership in whatever activity it may select. It dominates environment and advances into new undertakings. It is the mark of the Social Migrator, the man of initiative who extricates himself from the mass and changes some bit of the world for better or for worse, by his contact with it . . . Someone has said that if France, for example, were to lose fifty of her greatest statesmen, fifty leading scientists, fifty each of her shining lights in education, art, music, there would be nothing left of France. This states in an exaggerated way a deep truth which can be more convincingly illustrated."[4]

France is here used merely as an illustration; the same line of argument applies equally everywhere. Suppose that from any nation were taken 1% of the physically best men such as not of the "very best human values, are being lost in war, but of the best in intellectual and creative ability, in leadership, in genetic worth," what would be left?

Continuing, Mr. Humphrey asks what would become of New York, if 1% (40,000) of the best were removed. "In the physical display which any active nation can make we lose sight of the rather appalling fact that its constructively effective brains are concentrated in the heads of a very small number."

There exists, of course, in the mass a certain percentage who have not yet found themselves or found means of self-extrication. There are others yet to be produced through happy combinations of ancestral traits. But high endowments do not spring from nonentity. "Ability is never careless of its

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[2] No biologist who is qualified to express an opinion on the subject now fails to recognize the vast significance of Mendel's discovery. . . . But these admissions in no way affect our condemnation of the flimsy superstructure of speculation which has been erected by some of Mendel's successors. (Francis B. Sumner, *Modern Conceptions of Heredity*, La Jolla, Cal., p. 4)

[3] *Mankind*, p. 13.

[4] Seth K. Humphrey, *Mankind*, p. 38.

ancestry. . . . There are no 'self-made men." for each man has within him, derived from his intertangled ancestry, the potentiality of whatever he becomes."

REPAIR OF HUMAN WASTAGE AFTER WAR

We do not yet know how many men, women, and children have been killed, maimed, or ruined in the great war. The number runs very high, far into the millions already—thirty, forty or more—according to the completeness of our statistics. To replace these incalculable losses is a problem for future statesmanship. *Restoration of numbers*, however slow, is a matter relatively simple; *renewal in quality* a difficult process.

As has been abundantly pointed out, war first devours the young, selected for strength and endurance, "the best that the nation can bring." But the devastation, immeasurable as it is, by no means stops there. For with each man who falls perishes also the great widening wedge, reaching forward through time, of those who by rights should be his descendants. "Giving his life for his country," a man gives far more than that—he yields up his proportion of the "slain unnumbered" who are never to be.

Again, in addition to the millions fallen in battle, war takes its quota of civilians. Refugees of every description, men and women, children often lost or abandoned, trampled or starved in the rush, perish along the road, or are slain through "military necessity." Furthermore, everywhere behind the lines, war takes a corresponding toll, high-minded men and women breaking under the strain of a topsy-turvy world, the feeble and aged dying from want and neglect. It is often estimated that for each soldier who falls, two or three non-combatants also perish.

As an accompaniment of all this, the shadow of enforced celibacy is spreading over the womanhood of Europe. A world in which women hopelessly outnumber the men is sadly unnatural. It means that millions fitted for love and motherhood are to be debarred from the richest joys of life.

The best will accept the situation with no lowering of moral standards. But for the mass, indications point directly to some form of semi-legalized polygamy. The common run look to the state to formulate the moral law and ask no higher sanction than tacit official approval. In Germany, a plan for "lateral" or "secondary" marriages, another name for the semi-slavery of concubinage, has been repeatedly under discussion. But polygamy, in whatever form, brings disaster to social purity. Conventions guarding the most precious jewel of society cannot be discarded without a far-reaching heritage of evil.

To recapitulate, restoration in quantity is a matter of time. Restoration in quality, in values, moral, mental, and physical, will be a much longer and more difficult process. Still for a century to come the history of Europe will disclose its failure adequately to conserve the most forceful elements of its population. But as in the long run the strong and intelligent tend to outlast the futile, the dissipated, and the lawless, we may expect that after this, as after every war, there will be an ultimate although very tardy recovery.

Game-Bird Farming Needed

General prohibition of the sale of migratory birds has created a great demand for domesticated birds to supply the markets. To meet these demands the regulations under the migratory bird treaty act, made in 1916 between the United States and Great Britain for the protection of game birds migrating between this country and Canada, make liberal provisions for the propagation of migratory waterfowl.

Permits are issued free of charge by Secretary of Agriculture, through the Bureau of Biological Survey, authorizing persons to acquire a limited number of wild waterfowl to be used as the nucleus of a breeding stock or to strengthen the strain of birds already possessed.

A NOTE ON THE DROPPING OF FLOWERS IN THE POTATO[1]

M. J. DORSEY

Head of the Section of Fruit Breeding, Agricultural Experiment Station of the University of Minnesota

THERE is considerable popular interest in the failure of many potato varieties grown today to set seed. The varieties of our forefathers are generally supposed to have set seed-balls in abundance. It has been generally held that the cooler northern States such as Minnesota furnish conditions favorable to the development of seed-balls, but recently Newman and Leonian report seed-ball production in the Lookout Mountain variety (when grown as far south as Georgia) that certainly equals seed production farther north at its best. In fact these investigators are attempting to develop varieties which will produce by seed as well as by tubers. An occasional year when seed-balls are more abundant than others is well known, but the interest of growers centers more around those years when the flowers are abundant, but seed-balls rare, if any develop. The disposition of the flowers in the last case is the theme of this article.

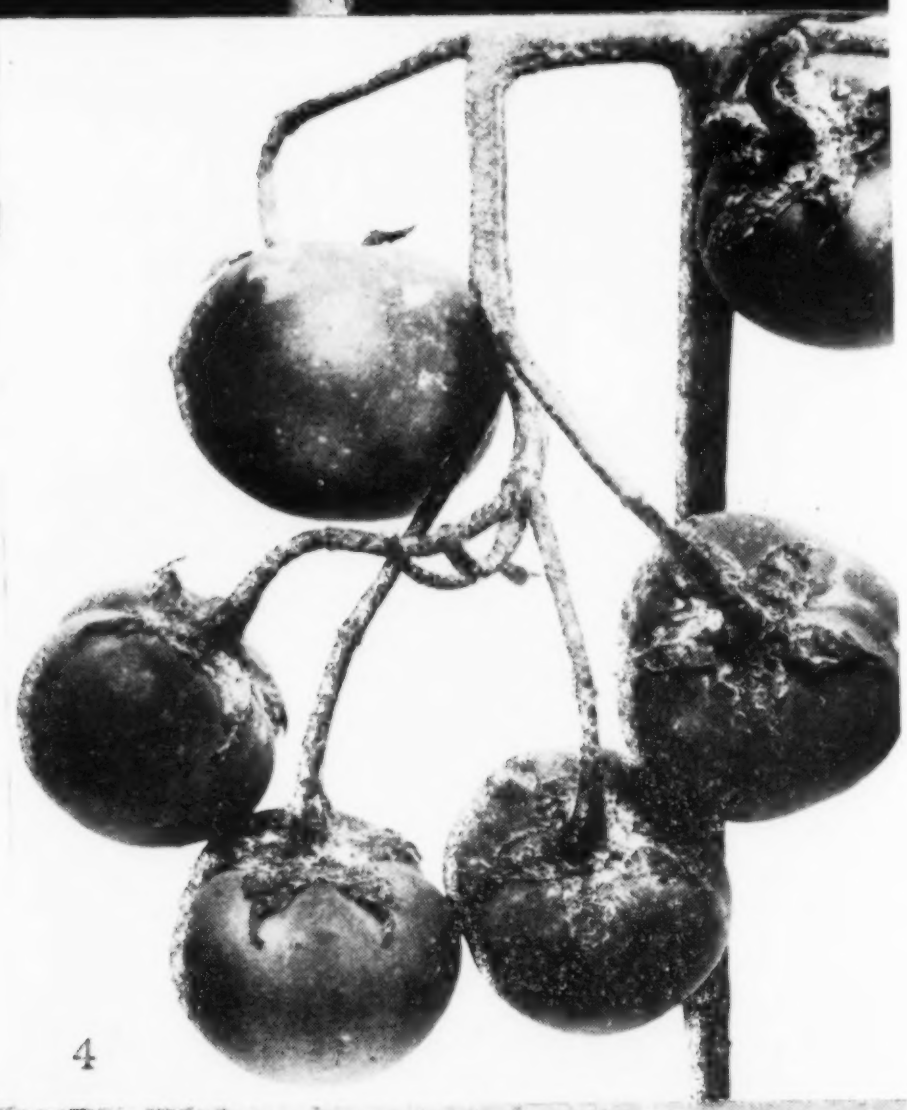
It should be stated that flower production varies from year to year and also that some varieties habitually bear fewer flowers than others. For instance, King seldom produces flowers, while Green Mountain bears them in abundance. It follows then that seed-ball production must also vary from year to year and between varieties. Some contend that seedlings bear more seed-balls than the older varieties.

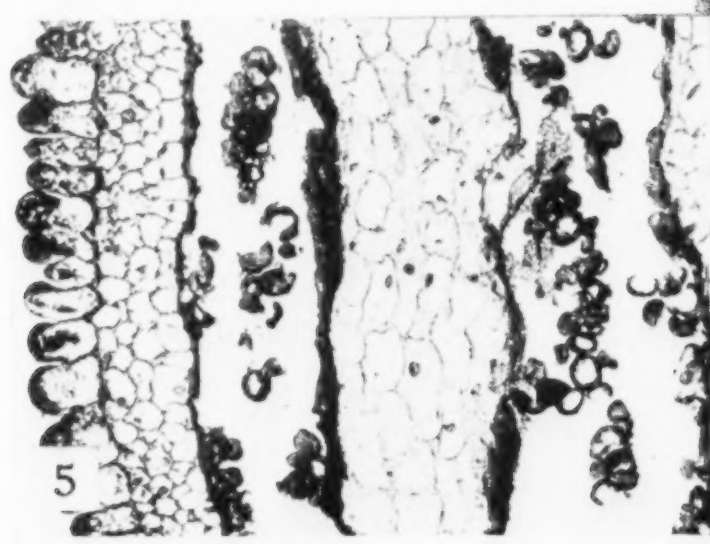
Early Ohio (Fig. 19, Nos. 1 and 2) and Rural New Yorker bore flowers in abundance at the Fruit Breeding Farm in 1918; but, like so many other seasons, all fell off so that at harvest time not a single seed-ball could be found in the entire patch. What happened? An examination of the blossoms when the first flowers were open showed that both the opened flowers and buds were falling in large numbers. In some clusters there was a partial succession of bloom, but the first flowers to open fell as the later ones came into bloom. In others the younger as well as older buds were falling several days in advance of the time they were due to open. In still others the younger buds fell before those which had come into full bloom. It is unusual to find dropping taking place simultaneously in flowers differing so much in age, because in most cases flowers normally fall after maturity.

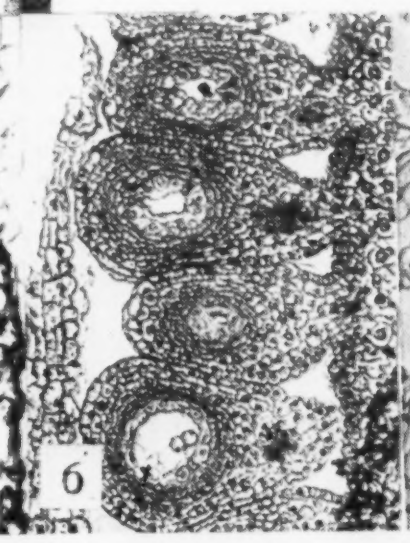
The joint in the pedicel (Fig. 19, No. 1) at which the flowers drop is three to five millimeters below the flower. There is a conspicuous swelling in the pedicel at this point, and before the flowers fall the stem is noticeably yellow in the younger buds as well as those which have opened. Buds or flowers sometimes drop on clusters in which seed-balls have already developed, and rarely even the younger seed-balls may drop. There is no abscission layer subtending the flower stalk, and after the flowers have all fallen off it persists and, in the absence of leaves at the base, dries up and can be found in this condition at maturity.

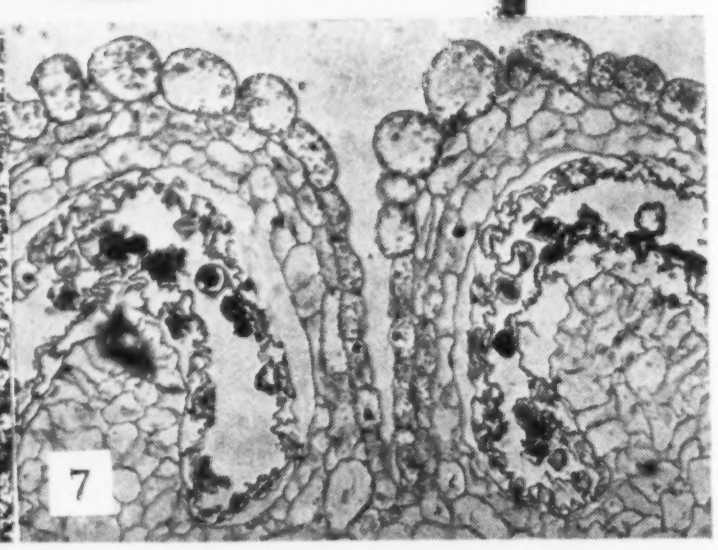
In many of the varieties a large percentage of the pollen is defective and in some no normal pollen is produced (Fig. 19, Nos. 5 and 7). Counts in a

[1] Published with the approval of the Director, as Paper 161 of the Journal Series of the Minnesota Experiment Station.









POTATO FLOWERS

(1) Early Ohio, flowers dropping before opening; (2) Early Ohio, flowers dropping after opening; (3) seed-balls setting on a cross between Keeper and Silverskin; (4) same as No. 3, showing greater development; note that some of the flowers on these two clusters have not set seed-balls; (5) longitudinal section of anther showing complete pollen abortion; (6) apparently normal ovule development in flowers which generally drop; (7) cross-section of an anther showing, as in No. 5, practically complete pollen abortion. (Fig. 19.)

few of the common varieties showed the following percentages of defective pollen: Beauty of Hebron, 30%; Early Norther, 44%; Early Rose, 60%; Green Mountain, 67%; White Elephant, 58%, and in a hybrid between Keeper and Silverskin, 89%. When pollen is taken from mature anthers and mounted in lactic acid the defective grains appear empty. The fact that there are empty pollen coverings in the loculi indicates that pollen development is stopped after being liberated from the tetrad. In anthers where there is complete pollen abortion at maturity the pollen appears white instead of the characteristic yellow. After dehiscence the anthers curve backward away from the style. It would appear from the above percentages, that while all of the varieties bear considerable quantities of aborted pollen, in most cases there would be ample normal pollen for self or cross pollination. In one collection of flowers from Early Ohio and Rural New Yorker there was nearly complete pollen abortion. If this were generally the case large fields of either of these varieties would fail to set seed-balls even if the flowers did not drop.

An examination of the pistil, on the other hand, shows that the ovules undergo normal development (Fig. 19, No. 6). There are evidences of disintegration in some embryo sacs but on the whole they appear to be undergoing the usual growth up to the time they are cut off when the flower drops. Some of the pistils are whitish in color at the base instead of distinct green before the flowers drop, and in those flowers which drop after opening, the abscission layer at the base of the style forms, and occasionally a flower persists long enough for the style to absciss. Receptive stigmas have very few pollen grains on them under field conditions. It often happens that seed-balls develop but bear few mature seeds. Apparently the stimulus from these is sufficient to hold the balls on.

What relation then does the dropping of flowers in the potato bear to the normal functioning of pollen and pistil? Since complete abortion of pollen occurs in many forms in which the pistil functions normally, this factor is not necessarily a cause of dropping, although pollen development is carried up to the liberated microspore. The pistil develops ovules and the stigma becomes receptive in the maturest flowers which shows that normal pistil development takes place in flowers in which the pollen is suppressed. Since the flowers are cut off before the stimulation resulting from pollination or fertilization takes place, this factor can be eliminated. Bloom, likewise, precedes any considerable storage of food material in the tuber. It appears then, that there are physiological influences operating independently of pollen or pistil development which cause the potato flower to drop.

Robert Louis Stevenson on Heredity

"Our conscious years are but a moment in the history of the elements that build us. . . . And though today I am only a man of letters, either tradition errs or I was present when there landed at St. Andrews a French barber-surgeon to tend the health and the beard of the great Cardinal Beaton: I have shaken a spear in the Debatable Land and shouted the slogan of the Elliots; I was present when a skipper, plying from Dundee, smuggled Jacobites to France after the '15. . . . Yes, parts of me have seen life, and met adventures, and sometimes met them well. And, away in the still cloudier past, the threads that make me up can be traced by fancy into the bosoms of thousands and millions of ascendants: Picts who rallied round Macbeth and the old (and highly preferable) system of descent by females, fliers from before the legions of Agricola, marchers in Pannonian morasses, star-gazers on Chaldean plateaus."

THE FOUNDERS OF THE ART OF BREEDING—III

Pre-Mendelian Breeders of the Nineteenth Century

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IN 1819 the Physical Section of the Royal Prussian Academy of the Sciences offered a prize for an answer to the question—"Does hybrid fertilization occur in the plant kingdom?" and this, despite the fact that as far back as 1761, Koelreuter, in the preface to his published work, had flattered himself with the hope that now "even the most stubborn doubter of the truth of the sexuality of plants would be completely convinced." "If, contrary to all conjecture," he says, "there should be such a one, who after a rigid examination, still maintained the contrary, it would astonish me as greatly as though I heard someone on a clear mid-day maintain that it was night." Fifty-six years after this utterance, however, the Prussian Academy still sought light in the darkness that Koelreuter had flattered himself to have dispelled.

On the third of July, 1826, the Academy's prize was conferred upon Dr. A. F. Wiegmann, physician of Braunschweig. Since the investigation did not, in the Academy's opinion, furnish a complete solution to the question, but half instead of the whole of the prize was granted. The award was made in the following language: "The author has described the results of his investigation with appropriate brevity. These results are in part completely convincing, and in part not," the reason being given that certain of Wiegmann's hybrid specimens submitted scarcely showed evidence of being of a hybrid character. Since, on the other hand, Wiegmann's results completely confirmed and extended those of Koelreuter, and especially by reason of his determination of the fact that self-fertilized hybrids may bear fertile seeds, it was decided to grant an award.

Wiegmann, through forty years of observation, including the fact of having actually produced two geranium crosses as early as his sixteenth year, was already predisposed toward the affirmative of the question submitted. His investigations, begun in 1822, were finally published in 1828. In order to overcome all possible criticisms from the opponents of the idea of sexuality in plants, which he considered might be directed against what he refers to as "an unnatural handling of plants in pots," he conducted his operations in the open ground, in connection with which he alludes to the several hindrances he was obliged to undergo, "weak sight, a trembling hand, and painful bending and kneeling" (p. 2).

Wiegmann refers to the many failures encountered, including the attempted repetition of a number of Koelreuter's experiments, as being probably due in part to having attempted crosses between different genera, "since many stigmas, according to my numerous experiments, take the pollen of too distant genera either not at all, or with extreme difficulty" (p. 2). "Plants which together are to produce hybrids," he says (p. 26), "must have some relationship with one another, as Koelreuter has already remarked. The nearer the parent plants are related to one another, the more easily will hybrid fertilization succeed; most easily in the case of different sub-species or varieties; then different species of the same genus; less easily in the case of plants of different genera."

Wiegmann, however, was completely free from any rigid dogmatic attitude on the species question. His views in this regard are completely modern.

Continuing the above, he says, "Yet at the same time, one needs indeed pay less attention to differences based on artificial generic characters. Genera like *Pisum* and *Vicia*, *Ervum* and *Vicia*, *Lychnia* and *Cucubalus*, are in their nature so related that hybrids can arise from them, as Koelreuter and I have demonstrated" (p. 27). "So much the more I dispute his opinion," he says of Koelreuter (p. 25), "respecting the falsely derived difference between true 'species' and 'variety' from the fertility or infertility of the hybrid plants."

CHANCE CROSSING IN NATURE

Wiegmann in fact regards chance crossing in nature, between species or sorts of plants, as having given rise to new agricultural races. "It appears from my experiments," he says (p. 26), "that many species, or constant subspecies, *e. g.*, *Pisum arvense*, *Vicia leucosperma*, *Vicia faba* (red-seeded), as well as the most of the varieties of cabbage and the cereals, whose origin is unknown, possibly are hybrid plants, which have been produced upon our fields and in our gardens, through the proximity of a few related plants, and which have remained constant."

Wiegmann sums up the matter of the bearing of degree of relationship upon crossing as follows (p. 27): "Mainly it comes to the point that the different plants do not vary from one another greatly in their natural constitution, and that their secretions are not too heterogeneous, since otherwise the pollinating substance would not be absorbed by the stigma. "In general," he says, "foreign pollen takes hold of the stigma with much greater difficulty than does its own, and in order to obtain complete fertilization, one must often deposit it several times, even when the foreign pollen is from a plant of the same species" (p. 3).

Wiegmann's experiments covered a list of thirty-six crosses, using the following species and cultivated varieties:

Allium (onion, etc.), 2 species.
Brassica (cabbage, etc.), 4 race-species.
Dianthus (pink), 3 species.
Ervum (lentil), 1 species.
Nicotiana (tobacco, etc.), 2 species.
Phaseolus (bean), 2 varieties.
Pisum (pea), 2 species.
Vicia (vetch), 1 species.

The general conclusions Wiegmann draws from his experiments are most interesting. The most important are those which relate to the possible vigor of new species (p. 3): . . . "My experiments sufficiently prove," he says, "that the fertilization of different subspecies, *inter se*, is a source of manifold running-out of species in the plant kingdom, and that insects, especially bees and humblebees, as well as little beetles and flies, play a much more important rôle in the fertilization of plants than one has lately been inclined to allow them, but of which I have the most indubitable proofs."

"Even though the structure of the corolla in the case of leguminous plants," he says again (p. 26), "scarcely appears to admit of the access of insects and foreign pollen, yet the plants obtained from the seed of experimental plants show such a striking alteration in their specific characters, especially in the form of the seed and its envelopes, that an influence of foreign pollen on the ovules will scarcely be able to be denied. I myself have numberless times convinced myself of the fact that humblebees, bees and small insects from the orders of flies and beetles, can fertilize the flowers of the Leguminosae in the manner stated by Sprengel. It is therefore necessary in agriculture to give heed to this matter, if one wishes to keep plants that are to be cultivated, in their quality and integrity."

With respect to observations of a more special nature, Wiegmann's memoir contains much of interest. Regarding the breaking up of the progeny of hybrids, he says, speaking of Koelreuter's observations: "I have found his observation well founded, that the plants produced from one seed and from one capsule of hybrid plants often differ from one another in respect to fertility, and especially in the struc-

ture of certain parts, now approximating more to the father, now to the mother" (p. 25).

Wiegmann's independence of traditional authority is witnessed in his contradiction of the view of "the great Linnaeus," that hybrids resemble the mother in the fertilization apparatus and the father in foliage and habit. Instead, he says: "the change through the foreign fertilizing pollen shows itself in very different parts in different plants; in the anther filaments, . . . in the inflorescence, in the form, color, and odor of the corolla, in the height of the stem and its divisions, in the form and outside covering of the leaf" (p. 23).

Referring to the then general assumption that hybrids (of the F_1 generation, as we should say) occupy a mid-position, with respect to their characters, between the two parents, he says: ". . . in many cases this does not occur, but either the color of the father or that of the mother shows itself alone dominant (herrshend) in the hybrid. The same also obtains among animal hybrids; the two colors may, through mingling, give an intermediate one, but in just as many cases the one only prevails. Plant hybrids therefore unite in themselves in part the peculiarities of the father, in part those of the mother, whereby they approach now the maternal, now the paternal form" (p. 21).

THE QUESTION OF DOMINANCE

Regarding the matter of dominance, Wiegmann further incidentally remarks upon the case of the crossing of two species of Dianthus, where "the form of the father has almost entirely suppressed that of the mother" (p. 22).

To present-day geneticists, one of the most interesting points in Wiegmann's report is his discussion of the immediate effect of the pollen in the case of peas. According to his statement, that there occurs, "even immediately after fertilization, an alteration arising in the form and color of the seed, and in the form and size of the pods, is especially unmistakable in the case of the leguminous plants, although otherwise all fruits and seeds of hybrid plants from other families, have never shown themselves to me to be different from those of the mother plants" (p. 23). And again, "The principle expressed by Gärtner, that the influence of foreign pollen changes nothing in the form and external character of the fruits and seeds of the mother plant, should, according to my investigations, undergo a modification in the case of the Diadelphia (Leguminosae), since, in the case of these, the foreign pollen exerts an immediate effect upon the form, color, and other characters of the fruits and seeds" (p. 29).

In the case of Phaseolus (common bean), he says; "Previous experiments have taught me that Phaseoli of one species, but of two kinds of flowers and seeds, when placed together, bear differently colored seeds, and, in the second generation, also differently colored flowers" (p. 23).

Wiegmann carried on some field experiments with beans, vetches, oats, and cabbage, in which adjoining rows of plants were allowed to freely cross-pollinate through the agency of wind and insects, from which he concluded: "It appears further, from the behavior of the Leguminosae and of cabbage, that agronomists and gardeners cannot be careful enough in the arrangement of their fields, in order not to suffer from the great damage through hybrid fertilization occurring even the first year" (p. 36).

Speaking generally, he says further (p. 30): "It is not entirely improbable that that which exhibited itself to me thus far, as being peculiar to the Leguminosae alone, may take place also among other plant-families, and the clearing up of this matter remains very desirable for botany, as well as for agriculture in particular" (p. 30).

Wiegmann's work, as a whole, impresses one as the work of a man without scientific prepossessions, willing to investigate for himself, to dispute freely the authority of other investigators such as Linnaeus, Koelreuter, and Gärtner, and, withal, a man with a practical bias and a sympathy for agriculture.

In the valley of the Nagold, in the Black Forest region of Württemberg, some 40 miles southwest of Stuttgart, the capital, lies the village of Calw. Here Koelreuter, whose home was in Sulz, a little way to the south in the Neckar valley, lived for a time, and did some of his work on hybridization, in the garden of a local physician. By a curious coincidence, in the same village of Calw in which Koelreuter had previously worked, and but 40 miles north of Sulz, where also Koelreuter had formerly obtained the first hybrid plant ever produced in a scientific experiment, lived and died Carl Friedrich von Gärtner, who for twenty-five years conducted extensive experimental work in hybridization. He was a son of the distinguished botanist Joseph Gärtner, Professor at Tübingen and St. Petersburg, and author of an authoritative work on the seeds and fruits of plants, in which figured the morphology of more than a thousand species. The introductions to the volume for 1788 contain, in the words of Sachs, "valuable reflections on sexuality in plants."

In 1830, two years after the appearance of Wiegmann's memoir, the Dutch Academy of Sciences at Haarlem, propounded the riddle of hybridization anew in the following words: "What does experience teach regarding the production of new species and varieties, through the artificial fertilization of flowers of the one with the pollen of the other, and what economic and ornamental plants can be produced and multiplied in this way?" No reply was received by the end of the time for which the prize was offered (January 1, 1833), and the offer was accordingly renewed for another three years (until January 1, 1836).

In October, 1835, Gärtner learned of the prize offer and was able to present a brief résumé of his work up to that time, which, indeed, prompted a further extension of time on the part of the Academy. Gärtner finally presented the Academy with a memoir of two hundred pages, and with herbarium mounts of one hundred and fifty different sorts of hybrid plants produced by hand pollination. On May 20, 1837, this memoir received the prize and was later (April 20, 1849), published in revised and extended form, together with an extensive list of the experimental material, and with the obtained results arranged in tabulated form.

An idea of the amount of labor expended by Gärtner during the twenty-five years of his hybridization experiments may be obtained by the statement that he carried out nearly ten thousand separate experiments in crossing, among about seven hundred species, belonging to eighty different genera of plants, and obtained in all some two hundred and fifty hybrid plants as the total result.

Among the prominent genera worked with were Althaea, Avena, Campion, Columbine, Currant, Datura (Jimson weed, etc.), Fox-glove, Fuchsia, Gladiolus, Larkspur, Lobelia, Maize, Mallow, Mullein, Nicotiana (Tobacco, etc.), Oenothera (Evening Primrose), Pink, Poppy, Primrose, Snapdragon, St. Johnswort, and Stocks.

The following brief table, giving some of the numerical data, in crosses involving a few of the principal genera, will afford a conception of Gärtner's labors; yet these constitute but one-tenth of the total number of his crosses.

Genus	*No. of species used in the crosses*	*No. of attempted combinations*	*No. of hybrid plants obtained*
Nicotiana (tobacco, etc.)	23	432	85
Dianthus (Pink)	20	349	87
Lychnis (Campion)	..	137	18
Verbascum (Mullein)	14	118	97
Lobelia	4	97	20
Digitalis (Foxglove)	9	59	14
Datura (Jimson weed, etc.)	8	55	16
Oenothera (Evening Primrose)	19	52	6
Aquilegia (Columbine)	9	33	23
	107	1332	366

Gärtner undertook to classify hybrids for convenience into three types: (1) intermediate, (2) commingled, and (3) decided. The first included those in which "a complete balance occurred of both fertilizing materials, either in respect to mass or activity" (p. 227). Commingled types are those in which "now this, now that part of the hybrid approaches more to the maternal or to the paternal form, whereby, however, the characters of the parents, in their transference to the new organism, never go over pure, but in which the parental characters always suffer a certain modification" (p. 282). Under the third class of hybrids, Gärtner places those "among which the resemblance of a hybrid to one of its parents, either to the father or the mother, is so marked and preponderating that the agreement with the one or with the other is unquestioned" (p. 285).

Gärtner recognized, as did the other hybridizers of his day, that there was always a difference between the first and the succeeding generations, the former being uniform, the later ones variously splitting up. He made no distinction between the second and the other following generations, and simply says that the fundamental ground material of which the hybrid is made "behaves differently in the second and in the further stages of breeding, where, on account of the different nature of the two factors of the hybrid in the succeeding fertilizations, an altered, shifting, variable direction in type-formation enters into the arising varieties" (p. 572).

He further says, concerning variability in hybrids of the second and succeeding generations: "Other hybrids, and in fact the most of them which are fertile, present from the seeds of the second and further generations, different forms, *i. e.*, varieties, varying from the normal types, which in part are unlike the original hybrid mother, or deviate from the same, now more, now less" (p. 422).

Gärtner's most definite statement, however, regarding what we call "segregation" in the second hybrid generation, is as follows: "Among many fertile hybrids, this change in the second and succeeding generations affects not only the flowers but also the entire habit, even to the exclusion of the flowers, whereby the majority of the individuals from a single cross ordinarily retain the form of the hybrid mother, a few others have become more like the original mother parent, and, finally, here and there an individual more nearly reverted to the original father" (p. 422).

Gärtner did not fail to recognize the fact of unusual vigor in hybrids, although he does not distinguish as to the generation: "The marked increase in the size of the flowers is a phenomenon not seldom occurring among hybrids" (p. 295); and "one of the most marked and general characters of plant hybrids is the luxuriance of all their parts, since, among very many of them, an exuberance of growth and development of roots, branches, leaves and flowers manifests itself, which is not encountered among the parents, even under careful cultivating" (p. 526).

PRACTICAL POSSIBILITIES

Gärtner recognized at once the possibilities for agriculture in this fact of the increased vigor of hybrids, although, of course, he did not realize the fact that this increased vigor belonged to the first or hybrid generation, properly so called: "Among the characters of hybrids worthy of recommendation for agriculture, their tendency toward luxuriance in stalks and leaves and their extraordinary capacity for tillering is related above. With respect to the raising of forage, agriculture could, without doubt, make great use of this characteristic" (p. 634).

Gärtner derived, from his long experience, a certain philosophy concerning the nature of hybrids which is noteworthy. He recognized an inequality in the influences or the "potency," as he termed it, of one parent over another in a cross, which potency was maintained, whichever way the cross was made. As we now understand it, it

means the relative dominance of one or more factors or character-units of the parents. Gärtner, not having the knowledge which has come since and in consequence of Mendel's investigations, sought a theoretical explanation for this phenomenon of dominance and gave it the designation of "sexual affinity)' (Wahlverwandschaft) in the crossing of species, the magnitude of which he considered could be measured by the number of viable seeds produced in the cross. Gärtner seems to confuse the matter by appearing to indicate that there might possibly be a different number of seeds produced by the reciprocals of reciprocal crosses, thus presumably indicating a possible "prepotency," so called, of one of the parents in the cross. In other places he simply seems to mean the relative influence, so to speak, of such and such species when crossed with others. This appears to be the meaning in the following:

"This manifestation of generic types, according to which one species acts in a predominant manner over several other species in hybrid breeding, is a further uncontradictable proof that the relationship of the forces, through which the union of two pure species takes place, must be unlike, and that thereby there can be no question of any balance of factors" (p. 290).

It will be seen that Gärtner's view of hybridization was that "species" was crossed with "species" as such, each species as a whole exerting its own relative power or potency in the cross—the hybrid being regarded as the resultant, so to speak, of the contest for supremacy of the two competing natures in the compound. This view is well enough expressed in the following passage: "Thus, just as there are species in a natural genus, which possess a prepotent fertilizing power upon several other species of their genus, so there are also species which exert upon several others such a typical predominating effect, not to an equal extent, to be sure, but still of such a nature that their operation, in all combinations, is to be recognized by a character in common.

Both of these forces are, however, of different kinds and follow different laws" (p. 289).

Gärtner did not realize, in spite of Sageret's experiments, that some individual characters of a parent might be found to dominate in a cross and others not. "The laws of hybrid types orient themselves, not toward the individual organs of plants—do not apply to a single part, *e. g.*, stems, leaves, etc.—but are applicable rather to the inner nature of species. The organs which determine the types of hybrids must therefore be investigated and compared in their totality and in their mutual inter-relationship. For the most part, the individuality of a hybrid expresses itself in its entire habit, but in this respect the flower, above other parts of the plant, is most frequently and plainly distinguished" (p. 251).

Gärtner made some crosses with corn and with peas to determine the question of the immediate influence of the pollen upon the character of the seed. In corn he got no results, because of crossing white corn with red, in which latter the color, being due to the skin or pericarp, does not show until the seeds of the following season ripen. In peas he crossed four varieties. In certain crosses, *e. g.*, Paris Wax (yellow) × Sugar Pea (greenish-yellow), Early Green Brockel (green) × Paris Wax (yellow), and Sugar Pea (greenish-yellow) × Dwarf Creeping (yellow), the yellow color dominates over the green in the hybrid seeds.

Gärtner's work is noteworthy, not only for the remarkable number of species with which he experimented but for the scrupulous care which he exercised in his operations, if we may judge from his own statements; as, for instance, the following:

"For complete assurance of the purity and reliability of the products of hybrid breeding, and for testing the conclusions derived therefrom, we have repeated most of the experiments, especially the doubtful cases, not once only, but several times, and put them to the test through crossing of the same species, for even with the most scrupulous foresight and precision, individual

rare instances have still occurred in these tedious and wearisome investigations, where the suspicion had made itself felt, of a mistake or error having crept in, either in pollination or emasculation, since such results stood in direct contradiction to the usual experiences, and on a repetition of the experiments, made itself incontrovertibly evident as an error. We believed it possible to attain no higher degree of certainty in this branch of natural science, and to be able to bring the conclusions derived therefrom to no higher proof, than through the precise coincidence of the forms of the products,by repetition under the same conditions with the same species, but with different individuals, and at different times" (p. 675).

THE ENGLISH BOTANISTS

At the beginning of the nineteenth century, there began to appear, in England, the first signs of the application of the science of hybridization to the practical art of breeding, in the work of Thomas Andrew Knight and William Herbert.

THE WORK OF KNIGHT

Knight was a country gentleman by occupation, born August 12, 1759, and educated at Oxford, and who early began to interest himself, on his estate at Elton in Herefordshire, in experiments in the raising of new varieties of fruits and vegetables. In 1795 his work as a horticulturist first became known through some papers read at the sessions of the Royal Society. He was an organizer of the Horticultural Society of London, founded 1804, of which he was president from 1811 until his death in 1838. He was an annual contributor to its "Transactions" and was the author of upwards of one hundred papers. In 1841, three years after his death, a collection of eighty-two of his papers was published by the botanists Bentham and Lindley. Of Knight's published papers, forty-six are enumerated in the Royal Society's Catalogue. Knight was not a scientific man, but a practical horticulturist with scientific instincts, who proceeded on the principle that the improvement of plants depended upon the same scientific laws as the improvement of animals, and that cross-breeding was the key to the origination of new and improved sorts. His principal work of crossing was carried out with currants, grapes, apples pears, and peaches, to the end of producing hardier and superior fruits. One of his discoveries of genetic interest was that, in crosses of varieties of red upon white currant, by far the greater number of the hybrids produced red fruit, *i.e.*, the dominance of red. A conclusion formulated by Knight on the basis of his experience, and afterwards confirmed by Darwin, and since called the Knight-Darwin law, was that "new varieties of every species of fruit will generally be better obtained by introducing the farina (pollen) of one variety of fruit into the blossom of another, than by propagating from one single kind."

However, the work of Knight that attracts the most attention from the standpoint of genetics is his experiment with peas. The paper in question, read before the Horticultural Society, June 3, 1823, was entitled: "Some Remarks on the Supposed Influence of the Pollen, in Cross-breeding, on the Color of the Seed-coats of Plants and the Qualities of Their Fruits." This paper is really, in part, a reply to certain phases of the experiments of John Goss upon the same plant. Knight's introductory statement, which follows, is a curious reminder, in point of form, of Mendel's own introduction to his report upon his experiments with peas nearly half a century later:

"The numerous varieties of strictly permanent habits of the pea, its annual life, and the distinct character in form, size and color of many of its varieties induced me, many years ago, to select it for the purpose of ascertaining, by a long course of experiments, the effects of introducing the pollen of one variety into the prepared blossoms of another. My chief object in these experiments, was to obtain such information as would enable me to calculate the prob-

able effects of similar operations upon other species of plants, and I believe it would not be easy to suggest an experiment of cross-breeding upon this plant, of which I have not seen the result, through many successive generations."

In the particular experiment in question, Knight determined that, in crossing a pea with grey seed-coats upon one with white seed-coats, no immediate change took place, but that the resulting hybrid seeds produced plants the next year which uniformly bore grey seeds, as well as having the purple-colored stems and flowers of the male parent. He further discovered the fact that by crossing plants grown from these (heterozygous) grey seeds, with pollen from what he calls a "permanent" white variety, plants of two types appeared, one bearing grey and the other white seeds—in other words, the result of the cross of a recessive white upon a hybrid dominant grey, as we should say nowadays. No numbers are reported, so that a scientific basis of ratios, as later found by Mendel, was not laid. Despite the fact that Focke says (p. 436) "he has contributed more to our knowledge of hybrids than any other writer during the first half of the nineteenth century" —a statement which may well be seriously disputed—it is nevertheless true that Knight was the first experimenter to apply the science of plant hybridization to plant improvement. Although endowed with scientific insight of no mean order, his chief claim to recognition lies in the fact that he possessed a practical instinct for getting improved orchard fruits into existence.

The following examples will serve to illustrate the nature of his results. Of his currant crosses, he says: "Five varieties, three red and two white. out of about two hundred, appeared to me to possess considerably greater merits than either of their parents, and one of the red will, I believe, prove larger than any red currant now in cultivation."

By crossing the "Noblesse" peach (female) by "Nutmeg," (male), he obtained about twenty seedlings, of which three "appeared better peaches than I previously possessed." Of one of these he says: "Its fruit has attained a more uniform degree of perfection than I have ever witnessed in any other variety. The trees have also been free from every vestige of mildew, in the situation where the disease is very prominent, and have entirely escaped the attacks of insects."

As to the result of his crosses of apple varieties with the Siberian Crab, with the object of producing fruits that would ripen in cold and exposed situations, he says: "The plants thus produced seem perfectly well calculated in every respect to answer the object of the experiment, and possess an extraordinary hardiness and luxuriance of growth."

WILLIAM HERBERT

The work of William Herbert was to a considerable extent contemporary with that of Knight. Born January 12, 1778, son of the Earl of Carnarvon, educated at Eton and Oxford, he was trained for the bar, which he finally left for the Church, entering orders and finally becoming Dean of Manchester. Fond of outdoor life and sport, he possessed also, in addition to literary talent, an instinct for plant studies. Herbert worked largely on the improvement of florists' flowers, but also conducted experiments with some agricultural plants. He was engaged for a considerable time upon his own experiments, before he came upon the work of Koelreuter, which he immediately assimilated and estimated at its true value, as the following comment indicates:

"The first experiments, with a view to ascertain the possibility of producing hybrid vegetables (plants) appears to have been made in Germany, by Koelreuter, who published reports of his proceedings in the Acts of the Petersburgh Academy between fifty and sixty years ago. Lycium, Digitalis, Nicotiana, Datura, and Lobelia were the chief plants with which he worked successfully, and as I have found nothing in his reports, to the best of my recol-

A PIONEER IN THE STUDY OF HEREDITY

Thomas Andrew Knight (1758-1838)

An English horticulturist who published in 1795 his views on the inheritance of diseases among fruit-trees, which attracted much attention. (Fig. 20.)

lection, opposed to my own general observations, it is unnecessary to state more concerning his mules, than the fact that he was the father of such experiments. They do not seem to have been at all followed up by others, or to have attracted the attention of cultivators or botanists as they ought to have done; and nothing else material on the subject has fallen under my notice of earlier date than Mr. Knight's report of his crosses of fruit trees, and my own of ornamental flowers, in the Transactions of the Horticultural Society of London. Those papers attracted the public notice, and appear to have excited many persons, both in this country and abroad, to similar experiments."

Herbert's experimental work was animated by the conviction of the fact which he felt himself to have established, that the then current botanical dogma was wrong, which regarded the existence of sterile offspring from a cross, as evidence that the two parents were of different "species." His views were contrary to those held at the time by Knight, in common with many botanists, "that the production of a fertile cross was proof that the two parents were of the same species," assuming, as a consequence, "that the sterile offspring was nearly conclusive evidence that they were of different species; and this dictum was advanced without suggesting any alteration in the definition of the term 'species,' but leaving it to imply what it has before universally signified in the language of botanists."

A PRECURSOR OF MENDEL

Besides the work of Knight and Herbert, an experiment from the first half of the nineteenth century, which has elicited considerable interest, because of its suggestion of the later discoveries of Mendel, is that of John Goss, of Hatherleigh, in Devonshire, England, with garden peas. In the summer of 1820, Goss pollinated flowers of the Blue Prussian variety with pollen of a dwarf pea known as Dwarf Spanish, obtaining, as the result of the cross, three pods of hybrid seeds. In the spring of 1821, when he opened these pods for planting, he was surprised to find that the color of the seeds (*i. e.*, of the cotyledons), instead of being a deep blue like those of the female parent, was yellowish-white like that of the male. Here was evidently a case of complete dominance of yellow-white over blue cotyledons. However, the plants growing from these seeds in that season "produced some pods with all blue, some with all white, and many with both blue and white peas in the same pod." Here was evidently a plain discovery of the fact of segregation, according to what later became known as Mendel's law. The following spring (1822) he separated the blue peas from the white, sowing the seeds of each color in separate rows. He found that the blue seeds, which we should now call the "recessives," produced in turn only blue seeds; while the white seeds, or "dominants" as they are now called, "yielded some pods with all white, and some with both blue and white peas intermixed." Here, then, is the typical case of the segregation of the heterozygotes or hybrid dominants.

Although Goss in this experiment undoubtedly made evident the facts of dominance and of segregation, he did not recognize them as such, nor did he, apparently, sow the seeds of his different plants separately, or make counts of the number of seeds of the two colors found on each separate plant, as did Mendel in his experiments. Goss was chiefly interested in the question of the possibility of the "new variety" having superior value as an edible pea, and yet remarked that, in case it possessed no superior merit, that there yet might be "something in its history that will emit a ray of physiological light." However, the "physiological light" did not appear until after the rediscovery of Mendel's papers in 1900. The paper of John Goss was read before the Horticultural Society, October 15, 1822. At the meeting of the 20th of August preceding, a communication was read on the same subject from Alexander Seton. Seton had pollinated the flowers

of the Dwarf Imperial, a grey-seeded pea, with the pollen of a tall white-seeded variety. One pod with four peas was produced, all of which were green, *i. e.*, the dominance of green cotyledon color over its absence (white). The plants growing from the four peas (F_1 seeds, as we should call them) were intermediate in size between the two parents, and the pods, on ripening, "instead of their containing peas like those of either parent, or of an appearance between the two, almost every one of them had some peas of the full green color of the Dwarf Imperial and others of the whitish color of that with which it had been impregnated, mixed indiscriminately and in undefined numbers; *they were all completely either of one color or the other, none of them having an intermediate tint.*" (Italics inserted.)

Here again were recorded the phenomena of dominance and of segregation, but owing to the fact that the numbers of seeds of each color of each plant were not counted and recorded separately, the results were not available for scientific purposes, nor would they have aroused attention any more than those of Goss, except for Mendel's later work with the same kind of plants.

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(*To be continued*)

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